

**DIVISION OF
AGRICULTURE**

**B.Sc. (Hons.) Agriculture - List of Courses with Revised Course Objectives and Outcomes /
References**

S.No.	Discipline	Course Code	Name of the Course	Credits
1.	Non-Gradial	20AG1010	Human values and Ethics	1(1+0)
2.	AGR	21AG1001	Fundamentals of Agronomy	4(3+1)
3.	AGR (Remedial)	21AG1002	Agricultural Heritage	1(1+0)*
4.	AGR	21AG1003	Introduction to Forestry	2(1+1)
5.	AEC	21AG1051	Fundamentals of Agricultural Economics	2(2+0)
6.	AEX	21AG1101	Communication Skills and Personality Development	2(1+1)
7.	AEN	21AG1151	Fundamentals of Entomology	4(3+1)
8.	GPB	21AG1201	Fundamentals of Genetics	3(2+1)
9.	SAC	21AG1301	Fundamentals of Soil Science	3(2+1)
10.	AGR	21AG1302	Introductory Agro-meteorology & Climate Change	2(1+1)
11.	SAC	21AG1303	Agricultural Microbiology	2(1+1)
12.	PAT	21AG1351	Fundamentals of Plant Pathology	4(3+1)
13.	AEG	21AG1451	Introductory Soil and Water Conservation Engineering	2(1+1)
14.	BTH	21AG1501	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
15.	BTH	21AG1503	Fundamentals of Crop Physiology	2(1+1)
16.	AGR	21AG2004	Crop Production Technology – I (<i>Kharif Crops</i>)	2(1+1)
17.	AGR	21AG2005	Crop Production Technology –II (<i>Rabi Crops</i>)	2(1+1)
18.	AGR	21AG2006	Farming System & Sustainable Agriculture	1(1+0)
19.	AGR	21AG2007	Practical Crop Production – I (<i>Kharif crops</i>)	2(0+2)
20.	AGR	21AG2009	Rainfed Agriculture & Watershed Management	2(1+1)
21.	AGR	21AG2010	Practical Crop Production –II (<i>Rabi crops</i>)	2(0+2)
22.	AGR	21AG2011	Principles of Organic Farming	2(1+1)
23.	AGR	21AG2012	Weed Management- Elective Course 2	3(2+1)
24.	AEC	21AG2052	Agricultural Finance and Cooperation	3(2+1)
25.	AEC	21AG2053	Agricultural Marketing Trade & Prices	3(2+1)
26.	AEC	21AG2055	Farm Management, Production & Resource Economics	2(1+1)
27.	AEX	21AG2102	Rural Sociology & Educational Psychology	2(2+0)
28.	AEX	21AG2103	Fundamentals of Agricultural Extension Education	3(2+1)
29.	Non-Gradial AEX	21AG2104	Educational Tour-I	1(0+1)
30.	Non- Gradial AEX	21AG2105	Educational Tour-II	1(0+1)
31.	AEX	21AG2106	Rural Agricultural Work Experience (RAWEx) and Agro-Industrial Attachment (AIA)	20(0+20)
32.	AEN	21AG2152	Pests of Crops and Stored Grain and their Management	3(2+1)
33.	AEN	21AG2153	Management of Beneficial Insects	2(1+1)
34.	GPB	21AG2202	Fundamentals of Plant Breeding	3(2+1)
35.	GPB	21AG2203	Principles of Seed Technology	3(1+2)
36.	GPB	21AG2204	Crop Improvement-I (Kharif Crops)	2(1+1)
37.	GPB	21AG2205	Crop Improvement-II (Rabi crops)	2(1+1)
38.	SAC	21AG2304	Environmental Studies and Disaster Management	3(2+1)
39.	AEG	21AG2305	Renewable Energy and Green Technology	2(1+1)
40.	SAC	21AG2306	Manures, Fertilizers and Soil Fertility Management	3(2+1)

41.	SAC	21AG2307	Problematic Soils and their Management	2(2+0)
42.	PAT	21AG2352	Diseases of Field and Horticultural Crops and their Management -I	3(2+1)
43.	PAT	21AG2353	Diseases of Field and Horticultural Crops and their management-II	3(2+1)
44.	PAT	21AG2354	Principles of Integrated Pest and Disease Management	3(2+1)
45.	ANS	21AG2401	Livestock and Poultry Management	4(3+1)
46.	AEG	21AG2452	Farm Machinery and Power	2(1+1)
47.	AEG	21AG2453	Protected Cultivation and Secondary Agriculture	2(1+1)
48.	AEC	21AG2551	Agri- Informatics	2(1+1)
49.	AEC	21AG2552	Intellectual Property Rights	1(1+0)
50.	HOR	21HO1251	Fundamentals of Horticulture	3(2+1)
51.	HOR	21HO1270	Production Technology for Fruit and Plantation Crops	2(1+1)
52.	HOR	21HO2271	Production Technology for Vegetables and Spices	2(1+1)
53.	HOR	21HO2272	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
54.	HOR	21HO2273	Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)
55.	HOR	21HO2274	Principles of Food Science and Nutrition	2(2+0)
56.	AGR	22AG2013	Geoinformatics, Nano-Technology and Precision Farming	2(1+1)
57.	AEC	22AG2056	Statistical Methods	2(1+1)
58.	AEX	22AG2108	Entrepreneurship Development and Business Communication	2(1+1)
59.	HOR	22HO2275	Landscaping- Elective Course 1	3(2+1)
60.	SAC	22AG2308	Agrochemicals- Elective Course 3	3(2+1)
61.	AGR	23AG2012	System Simulation and Agro Advisory	3(2+1)
62.	AEC	23AG2057	Agri-Business Management	3(2+1)
63.	AEX	23AG2109	Experiential Learning Program-Seed Production Technology	0+10
64.	AEX	23AG2110	Experiential Learning Program-Soil, Plant, and Water testing Services	0+10
65.	AEX	23AG2111	Experiential Learning Program-Organic Production Technology	0+10
66.	AEX	23AG2112	Experiential Learning Program-Commercial Floriculture and Landscaping	0+10
67.	AEX	23AG2113	Experiential Learning Program-Commercial Nursery Management and Protected Cultivation	0+10
68.	AEX	23AG2114	Experiential Learning Program-Production Technology of Biofertilizer	0+10
69.	AEX	23AG2115	Experiential Learning Program-Mushroom Cultivation Technology	0+10
70.	AEX	23AG2116	Experiential Learning Program-Commercial Beekeeping	0+10
71.	AEX	23AG2117	Experiential Learning Program-Agribusiness Management	0+10
72.	AEX	23AG2118	Experiential Learning Program-Agricultural Information Support Services	0+10
73.	AEX	23AG2119	Experiential Learning Program-Broiler Production Technology	0+10
74.	AEX	23AG2120	Experiential Learning Program-Food Processing	0+10
75.	AEX	23AG2121	Experiential Learning Program-Production Technology of Biocontrol Agents	0+10

76.	AEX	23AG2122	Experiential Learning Program-Commercial Sericulture	0+10
77.	AEX	23AG2123	Experiential Learning Program-Crop Production and Processing of Turmeric	0+10
78.	AEX	23AG2124	Experiential Learning Program-Crop Production and Storage of Small Onion	0+10
79.	AEX	23AG2125	Experiential Learning Program-Quail Production Technology	0+10
80.	AEX	23AG2126	Agricultural Journalism	3(2+1)
81.	GPB	23AG2205	Commercial Plant Breeding	3(1+2)
82.	SAC	23AG2309	Biopesticides & Biofertilizers	3(2+1)
83.	AEG	23AG2454	Protected Cultivation	3(2+1)

20AG1010 HUMAN VALUES AND ETHICS

Credits: 1:0:0 (1+0)

Course Objectives:

Enable the student to:

1. Understand value-based living.
2. Become a good leader.
3. Identify humanitarian problems and offer solutions.

Course outcomes:

The student will be able to:

1. Demonstrate the importance of value-based living.
2. Gain deeper understanding about the purpose of their life.
3. Become value- based professionals.
4. Lead a balanced life with emotional stability.
5. Set realistic goals in life and start working towards them.
6. Become leaders with social concern.

21AG1001 FUNDAMENTALS OF AGRONOMY

Credits: 3:0:1 (3+1)

Course Objectives:

Enable the student to:

1. Review the history of agriculture, scope and importance and classify the crops and cropping seasons.
2. Understand the crop growth and development with respect to agronomic requirements and practices.
3. Relate crop nutrition and fertilizer recommendation, weed management and cropping systems with production and productivity.

Course outcomes:

The student will be able to:

1. Apply the principles in crop adaptation and distribution linking with the agroclimatic zones, crop classification, plant ideotypes, plant allelopathy.
2. Acquire skills on tillage, types of tillage, tillage implements, seeds and sowing, crop geometry and density in relation to optimum crop population.
3. Optimize the water requirement of crops in relation to growth and development.
4. Recommend manures, fertilizers and appropriate weed management techniques at different phenophasic stages.
5. Acquire knowledge on crop rotation and cropping systems in Tamil Nadu and different parts of India.
6. Apply basic concepts of harvest and threshing in order to reduce harvest loss and post-harvest technology, storage and marketing.

21AG1002 AGRICULTURAL HERITAGE

Credits: 1:0:0 (1+0)

Course Objectives:

Enable the students to:

1. Comprehend the origin, history, evolution and importance of agricultural systems and resources.
2. Relate agricultural developments and green revolution.
3. Understand the agricultural education, farm mechanization and women empowerment.

Course Outcomes:**The students will be able to:**

1. Acquire knowledge on agricultural heritage, agricultural resources and development of Indian agriculture from ancient to modern era.
2. Compare indigenous traditional knowledge in agriculture and crop voyage in India and the world.
3. Apply Indigenous Traditional Knowledge (ITK) in modern agricultural practices.
4. Propose solutions related to natural calamities and famines.
5. Describe gender perspective, tasks of farm women, women empowerment and self-help groups.
6. Acquire skills on women friendly farm mechanization, ergonomical approaches and technological options.

21AG1003 INTRODUCTION TO FORESTRY**Credits: 1:0:1 (1+1)****Course Objectives:****Enable the students to:**

1. Understand the forestry and agroforestry systems in sustaining the land productivity.
2. Comprehend the crop tree interactions in different types of agroforestry systems.
3. Relate the productive and protective functions of agroforestry.

Course Outcomes:**The students will be able to:**

1. Recall the forest eco-systems and forest regeneration.
2. Apply the concepts of agroforestry practiced in various agro ecosystems.
3. Acquire the knowledge for developing agro forestry, wind breaks, shelter belts, silviculture and social forestry.
4. Categorize the multipurpose trees in agroforestry systems.
5. Analyze the impact of nitrogen fixation, carbon sequestration and develop strategies for climate mitigation.
6. Evaluate the beneficial effects of agro forestry in relation to nitrogen fixation, soil conservation, litter dynamics and nutrient cycles.

21AG1051 FUNDAMENTALS OF AGRICULTURAL ECONOMICS**Credits: 2:0:0 (2+0)****Course objectives:****Enable the student to**

1. Understand the basic principles of economics applicable to agricultural sector.
2. Acquire knowledge of economic decision-making concepts and conduct an in-depth assessment on micro and macroeconomic principles.
3. Gain knowledge on Indian Economy including National Income, GDP, and GDP per capita etc.,

Course Outcomes:**The student will be able to**

1. Examine the principle and theories, and its role in economic development plans for the country.
2. Relate consumer behavior-utility maximization problem with demand and supply theory.
3. Review the fundamental concepts of production, cost and price, output determination across market frameworks.
4. Comprehend the demographic situation population and factors that contribute to population growth.
5. Explain the National Income and taxation measures.
6. Evaluate the theory of general equilibrium and welfare economics.

21AG1101 COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT

Credits 1:0:1 (1+1)

Course Objectives

Enable the students to:

1. Understand structural and functional grammar.
2. Excel in writing and oral presentation skills
3. Participate effectively in group presentations and group discussions

Course Outcomes

Students will be able to:

1. Apply indexing, footnote and bibliographic procedures
2. Read and comprehend articles and written materials.
3. Apply the précis writing technique in summary and abstract writing.
4. Participate and organize group discussions and seminars.
5. Improve listening, writing and oral presentation skills
6. Create and maintain field diary and lab record.

21AG1151 FUNDAMENTALS OF ENTOMOLOGY

Credits: 3:0:1 (3+1)

Course objectives:

Enable the students to:

1. Understand the insect morphology, anatomy and physiology.
2. Gain knowledge on insect systematics.
3. Acquire knowledge on insect ecology, classification of pesticides and concept of different pest management techniques.

Course outcomes:

The students will be able to:

1. Understand the origin and evolution of Insects.
2. Examine the insect external body parts and their modifications.
3. Identify and classify the insects according to their orders and families.
4. Examine the anatomy of internal organs and their functions.
5. Analyze the factors influencing pest occurrence.
6. Apply the fundamental knowledge on integrated pest management strategies.

21AG1201 FUNDAMENTALS OF GENETICS

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand foundations of heredity.
2. Comprehend mechanisms of inheritance.
3. Explore advanced genetic concepts.

Course Outcomes:

The students will be able to:

1. Recall Mendelian inheritance and chromosome structure.
2. Explain chromosomal inheritance and apply probability concepts.
3. Solve genetic problems involving dominance and multiple alleles.
4. Examine chromosome variations and its effects on character expression.
5. Evaluate sex determination, mutations, and their impacts.
6. Develop insights into gene regulation and function.

21AG1301 FUNDAMENTALS OF SOIL SCIENCE

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the student to:

1. Understand the basic concepts of soil genesis and classification.
2. Gain knowledge on physical, chemical and biological properties of soil.
3. Comprehend the concept of soil health, soil pollution and appropriate remediation measures.

Course Outcomes:

The student will be able to:

1. Apply pedological and edaphological concepts of soil genesis.
2. Conceptualize soil taxonomy and classification of soils in India.
3. Analyze the basic physical properties of soil.
4. Analyze the basic chemical properties of soil.
5. Examine the biological properties of soil and its influence on soil health.
6. Analyze the behaviour of soil pollutants and recommend suitable remedial measures.

21AG1302 INTRODUCTORY AGRO-METEOROLOGY & CLIMATE CHANGE**Credits: 1:0:1 (1+1)****Course Objectives:****Enable the students to:**

1. Understand the agricultural meteorology and its role in crop production
2. Comprehend the atmospheric weather variables, climatic factors and their measurements.
3. Relate climate change and its effect on crop production.

Course Outcomes:**The students will be able to:**

1. State the significance of meteorology, agricultural meteorology, climate and weather.
2. Categorize the various atmospheric weather parameters and their role in crop production.
3. Apply the crop weather relationships for efficient crop production.
4. Acquire skills on weather forecasting techniques on crop ecosystems.
5. Recall the microclimatic and weather modification, types of precipitation, and monsoon mechanism in Indian agriculture.
6. Assess the impact of climate change and its effects on agriculture.

21AG1303 AGRICULTURAL MICROBIOLOGY**Credits: 1:0:1 (1+1)****Course Objectives:****Enable the students to:**

1. Understand the role of microorganisms in agriculture and soil microbiology.
2. Gain knowledge in the classification of microorganisms their functions and role in soil fertility
3. Understand the scope of microbes in human welfare, production of silage, biofertilizers, biopesticides, biofuels, and biodegradation of agricultural wastes.

Course Outcomes:**The students will be able to:**

1. Comprehend the importance and role of microbes in agricultural production.
2. Apply the principles of microscopy, sterilization techniques and nutrient media preparation.
3. Enumerate microbial load in soil and perform isolation, culturing and purification of microbes.
4. Demonstrate the mechanism of microbial activity in enhancing soil fertility.
5. Employ genetic transformation methods of using microbes in crop improvement.
6. Explore and develop biofertilizers, biopesticides and biofuels.

21AG1351 FUNDAMENTALS OF PLANT PATHOLOGY**Credits: 3:0:1 (3+1)****Course Objectives:****Enable the student to**

1. Gain knowledge on plant diseases and plant pathogens.
2. Understand the taxonomy and life cycle of plant pathogens.
3. Acquire knowledge on basics of plant disease management.

Course Outcomes:**The student will be able to**

1. Review the factors responsible for disease development.
2. Analyze the importance of various plant pathogens with their taxonomical characters.
3. Correlate the reproduction, survival and transmission of plant pathogens with disease development.
4. Conceptualize the mode of dispersal, role of enzymes and toxins in disease development.

5. Analyze defense mechanism in plants and the epidemiological factors.
6. Acquire skills on plant disease management.

References

1. Agrios, G.N. 2005. Plant Pathology. (5th Ed.), Elsevier Academic Press. 882p
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 2014. Introductory Mycology (4th Ed.), Wiley India Pvt Ltd. 833p
3. Alice D and Jayalakshmi C. 2018. Fundamentals of Plant pathology (2nd Ed.) (Reprint, 2022), Sri sakthi promotional litho press. Coimbatore 382p
4. Dasgupta M.K 1994 Principles of Plant Pathology, Allied Publishers, 1040pp
5. Jayaraman, J. and Verma, J.P. 2002. Fundamentals of Plant Bacteriology (Reprint, 2015), Kalyani publishers, New Delhi
6. Ravichandra, N.G. 2013. Fundamentals of Plant Pathology, PHI Learning Pvt Ltd. 639p.
7. Walkey, D. G. 1991. Applied Plant Virology (2nd Ed.), Springer, 352p.
8. Webster, J. and Weber, R.W.S. 2007. Introduction to Fungi (3rd Ed.), Cambridge University press. 817 p.
9. Thorne, G. 1971. Principles of nematology, McGraw Hill Book Co., New York, London, 553p.

21AG1451 INTRODUCTORY SOIL AND WATER CONSERVATION ENGINEERING**Credits: 1:0:1 (1+1)****Course Objectives:****Enable the students to:**

1. Understand the agents of soil erosion.
2. Acquire knowledge on factors influencing soil erosion.
3. Gain skills for adoption of soil and water conservation measures.

Course Outcomes:**The students will be able to**

1. Comprehend the causes and adverse effect of soil erosion.
2. Classify different stages of erosion.
3. Analyse soil losses using USLE.
4. Recommend water harvesting techniques.
5. Suggest suitable soil and water conservation measures for water erosion.
6. Apply different soil and water conservation control measure for wind erosion.

21AG1501 FUNDAMENTALS OF PLANT BIOCHEMISTRY AND BIOTECHNOLOGY**Credits: 2:0:1 (2+1)****Course Objectives:****Enable students to**

1. Understand the effect of abiotic stresses in reducing crop productivity
2. Gain insight into the physiological mechanism of abiotic stress tolerance
3. Understand the molecular basis of abiotic stress tolerance for plant breeding

Course outcomes:**Students will be able to**

1. Examine the abiotic stresses affecting crop productivity and their interaction with biotic stresses
2. Apply the principles of crop breeding under stress for improving crop productivity
3. Analyze the physiological changes that imparts abiotic stress tolerance in crops.
4. Analyze the molecular mechanisms that imparts abiotic stress tolerance in crops.
5. Compare the stress mechanisms at cellular and leaf level and their cross talk
6. under various abiotic stresses.
7. Investigate the regulatory mechanisms and key genes for abiotic stress tolerance in crop improvement programs.

21AG1503 FUNDAMENTALS OF CROP PHYSIOLOGY**Credits: 1:0:1 (1+1)****Course Objectives:****Enable the students to:**

1. Understand the concept of water relations in plants.

2. Gain knowledge on the physiological processes of plant and its effects on plant growth.
3. Assess the role of plant growth regulator and its application in crop growth

Course Outcomes:

On completion of this course, students will be able to

1. Characterize the physiology of plant tissues and cells.
2. Demonstrate water movement in plant systems like diffusion and osmosis.
3. Apply the concept of water relations and mineral uptake in the field of agriculture.
4. Analyze the physiological parameters of crops.
5. Correlate physiological roles with agricultural productivity.
6. Practice the use of growth regulators for solving physiological problems.

21AG2004 CROP PRODUCTION TECHNOLOGY - I (KHARIF CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Identify the crops and cropping systems for *kharif* season.
2. Understand the economic importance of *kharif* crops.
3. Comprehend the agronomic practices of *kharif* crops.

Course Outcomes:

The students will be able to:

1. Recognize the origin and geographical distribution of major *kharif* crops.
2. Remember soil and climatic requirements of different *kharif* crop varieties.
3. Recall the morphological features and crop production requirements for *kharif* season crops.
4. Review the crop establishment techniques for *kharif* crops.
5. Acquire the knowledge on cultivation and intercultivation practices for *kharif* season crops.
6. Apply the acquired knowledge on harvest and post-harvest techniques of *kharif* crops.

21AG2005 CROP PRODUCTION TECHNOLOGY-II (RABI CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Identify the crops and cropping systems for *rabi* season.
2. Understand the economic importance of *rabi* crops.
3. Comprehend the agronomic practices of *rabi* crops.

Course Outcomes:

The students will be able to:

1. Recognize the origin and geographical distribution of major *rabi* crops.
2. Remember soil and climatic requirements of different *rabi* crop varieties.
3. Recall the morphological features and crop production requirements for *rabi* season crops.
4. Review the crop establishment techniques for *rabi* crops.
5. Acquire the knowledge on cultivation and intercultivation practices for *rabi* season crops.
6. Apply the acquired knowledge on harvest and post-harvest techniques of *rabi* crops.

21AG2006 FARMING SYSTEMS & SUSTAINABLE AGRICULTURE

Credits 1:0:0 (1+0)

Course Objectives:

Enable the students to:

1. Understand the concepts of farming systems and sustainable agriculture.
2. Compare farming systems and its interaction in farm productivity.
3. Comprehend the efficiency of farm productivity through integrated farming systems.

Course Outcomes:

The students will be able to:

1. Differentiate the types of farming and cropping systems.
2. Define the importance of sustainability in agriculture.
3. Relate sustainable agriculture and conventional agriculture.
4. Evaluate the indicators of sustainability, adaptation, mitigation and conservation.

5. Formulate site-specific integrated farming systems for sustainability.
6. Assess resource cycling in different farming systems.

21AG2007 PRACTICAL CROP PRODUCTION-I (KHARIF CROPS)

Credits 0:0:2 (0+2)

Course Objectives:

Enable the students to:

1. Practice the cultivation of a major *kharif* crop.
2. Practically observe and study the phenological phases of a major *kharif* crop.
3. Calculate and estimate the growth and yield of a major *kharif* crop.

Course Outcomes:

The students will be able to:

1. Demonstrate practical cultivation of *kharif* crops.
2. Identify the problems in *kharif* cultivation and propose solutions
3. Operate modern farm equipment.
4. Implement the recommend package of practices for a *Kharif* crop.
5. Identify the marketing channels for the cultivated produce.
6. Construct a balance sheet showing cost of cultivation and net income generated.

21AG2009 RAINFED AGRICULTURE & WATERSHED MANAGEMENT

Credits 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Understand rainfed agriculture systems, land suitability, and farming practices in rainfed regions
2. Comprehend the adaptation and mitigation strategies, crop planning and crop management techniques for rainfed agriculture.
3. Appreciate the concepts, principles and components of watershed management.

Course Outcomes:

The students will be able to:

1. Evaluate sustainable agriculture practices under rainfed conditions.
2. Recall the soil and climatic conditions of rainfed areas.
3. Explain the various crop management techniques and the adaptation strategies for dry land agriculture
4. Formulate contingent water planning for aberrant weather conditions
5. Apply knowledge of different water conservation methods and effective water utilization through use of watershed management
6. Compute soil conservation strategies through watershed management

21AG2010 PRACTICAL CROP PRODUCTION-II (RABI CROPS)

Credits 0:0:2 (0+2)

Course Objectives:

Enable the students to:

1. Practice the cultivation of a major *rabi* crop.
2. Practically observe and study the phenological phases of a major *rabi* crop.
3. Calculate and estimate the growth and yield of a major *rabi* crop.

Course Outcomes:

The students will be able to:

1. Demonstrate practical cultivation of *rabi* crops.
2. Identify the problems in *rabi* cultivation and propose solutions
3. Operate modern farm equipment.
4. Implement the recommend package of practices for a *rabi* crop.
5. Identify the marketing channels for the cultivated produce.
6. Construct a balance sheet showing cost of cultivation and net income generated.

21AG2011 PRINCIPLES OF ORGANIC FARMING

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Comprehend the historical, physio-chemical, biological and ecological basis of organic farming practices.
2. Appreciate the agronomic practices and farming techniques under organic farming.
3. Be aware of the certification process and the standards of organic crop production and marketing

Course Outcomes:

The students will be able to:

1. Recognize the scope and opportunities for organic farming.
2. Remember the principles and concepts of organic farming.
3. Apply the nutrient management practices for organic crop production.
4. Optimize the insect pest, disease and weed management measures for organic crop production.
5. Understand the certification process and the standards of organic farming.
6. Evaluate the marketing and export potential of organic products.

21AG2012 WEED MANAGEMENT- Elective Course 2

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Relate different types weeds and its impact on crop production
2. Review herbicides and its application in weed control
3. Comprehend different methods of weed control in crop production.

Course Outcomes:

The students will be able to:

1. Identify different types of weeds and their ecosystem
2. Understand the weeds survival mechanisms
3. Recommend herbicides understanding their effects on the crops
4. Adopt different weed control methods
5. Apply integrated weed management practices
6. Workout the economics of weed control in horticultural crops

21AG2052 AGRICULTURAL FINANCE AND COOPERATION

Credits: 2:0:1 (2+1)

Course objectives:

Enable the students to:

1. Acknowledge the important role those financial institutions played in regulating the flow of credit in the rural economy.
2. Comprehend the lending patterns for the agricultural sector to alleviate poverty and boost the rural economy.
3. Familiar with the fundamental principles governing cooperative credit organizations and to obtain a practical knowledge of their management, strategies, and practices.

Course Outcomes:

The students will be able to:

1. Critically comprehend the development of the banking industry in India and issues with agricultural financing.
2. Explain the basic principles of financial systems and their role in lending various types of loans to the farmers.
3. Develop skills in credit analysis, dealing with bankers, loan application procedures.
4. Evaluate the behavior and performance of higher financial institutions across the world.
5. Acquire knowledge on the importance of farming cooperatives and the successful cooperative systems in India.
6. Provide knowledge on the techniques needed to create and evaluate project reports and financial statements.

21AG2053 AGRICULTURAL MARKETING TRADE & PRICES

Credits: 2:0:1 (2+1)

Enable the students to:

1. Impart knowledge on trade, market structure and classification, marketing process
2. Explore demand and supply strategies for agricultural products in a market-oriented framework.
3. Teach business ideas, marketing methods, marketing institutions, and how to overcome marketing barriers.

Course Outcomes:

The students will be able to:

1. Examine the structure and operation of local, national, and global agricultural markets, as well as quality control methods and standards.
2. Recognize different marketing activities and services that take place as agricultural commodities go from the farm gate to the plate.
3. Analyze the demand and supply problems in agricultural marketing systems, marketing efficiency and policies.
4. Acquire knowledge on customer and market trends, behavior of marketers and the food service industry.
5. Explain public and private sector marketing institutions, as well as the role of government in regulating markets and setting prices.
6. Discuss agricultural trade, policy, trade restrictions, and international organizations and trade agreements.

21AG2055 FARM MANAGEMENT, PRODUCTION & RESOURCE ECONOMICS

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Familiar with economic principles, cost concepts, theory underlying resource allocation and decision- making process
2. Recognise the risks and uncertainties in agriculture, crop insurance, resource economics, externalities, and common property resource management.
3. Make a farm Layout and computation of farm assets, organisation and management of enterprises, with a focus on optimal enterprise combinations to achieve household goals

Course Outcomes:

The students will be able to:

1. Evaluate the principles and theories used to improve farm management in order to make agricultural industry more profitable
2. Determine the physical and economic maximum point of output.
3. Offer efficient resource management methods in agricultural farming, livestock, and other linked enterprises
4. Analyse the agricultural production function using various programming techniques to plan the ideal enterprise combination to achieve household goals.
5. Deal with risk and unpredictability in the agriculture economy and be able to initiate start-ups on his own
6. Evaluate the techniques for managing common resources and to assess economic issues associated to natural resource utilisation, particularly climate change issues

21AG2102 RURAL SOCIOLOGY & EDUCATIONAL PSYCHOLOGY

Credits: 2:0:0 (2+0)

Course objectives:

Enable the students to:

1. Understand the sociological behaviour of rural people including farmers
2. Know the functions of rural society, social stratification and social changes
3. Learn the behavioral pattern and theories of motivation

Course Outcomes:

The students will be able to:

1. Familiarize with the basic concepts of rural sociology
2. Apply the rural sociology principles in agricultural extension

3. Assess the behavioral pattern among farmers and villagers
4. Apply the principles of educational psychology in farmers' training and communication
5. Analyse rural social institutions.
6. Develop skills in motivating farmers in learning new farm practices.

21AG2103 FUNDAMENTALS OF AGRICULTURAL EXTENSION EDUCATION

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the concept of extension education and its importance in Agriculture development.
2. Analyse the rural development programs aimed at poverty alleviation employment generation.
3. Learn the new innovations being brought into the Agricultural Extension in India.

Course Outcomes:

The students will be able to:

1. Develop knowledge on agricultural extension and rural development.
2. Help farmers and villagers to derive benefit from different schemes operated by state and central governments.
3. Conceptualize innovations in agricultural extension in rural areas.
4. Apply technology transfer techniques from lab to land for higher agriculture productivity.
5. Create awareness among farmers about information sources and materials for scientific farming.
6. Apply the knowledge and skill in uplifting poor and marginal farmers.

21AG2104 EDUCATIONAL TOUR – I (Non-Gradual)

Credits 0:0:1 (0+1)

Course Objectives:

Enable the students to:

1. Visualize the functioning of agricultural research institutions throughout the state.
2. Familiarize with the On-going agricultural research and extension programs.
3. Gain knowledge about the region specific crop production technologies

Course Outcomes:

The students will be able to:

1. Categorize agricultural crops grown in the different agro climatic zones of Tamil Nadu.
2. Classify different agro-climatic zones of Tamil Nadu.
3. Distinguish social, cultural and economic differences in various agricultural zones.
4. Compare and contrast the different soil types and cropping systems in Tamil Nadu.
5. Recommend climate and region-specific cultivation practices.
6. Analyze different rainfall patterns of different agro-climatic zones of Tamil Nadu.

21AG2105 EDUCATIONAL TOUR – II (Non-Gradual)

Credits 0:0:1 (0+1)

Course Objectives:

Enable the students to:

1. Visualize the various crops and cropping systems of South India.
2. Observe the various agricultural and agro-based institutions/ Research Stations/ Colleges in South India
3. Understand the ongoing agricultural research and extension programs implemented by the Government and the State Agricultural Universities

Course Outcomes:

The students will be able to:

1. Identify the various crops across the states of South India
2. Discuss the cropping systems practiced in the different agro-climatic zones of South India
3. Describe the soils, irrigation practices, sources of irrigation and other farming related activities in different parts of their visit
4. Assess the scope of farming, agro-based industries and related activities across the states of South India.
5. Relate the social and cultural aspects of the people of different agricultural zones

6. Discuss the commercial operations of farming and related activities

21AG2106 RURAL AGRICULTURAL WORK EXPERIENCE (RAWE) AND AGRO-INDUSTRIAL ATTACHMENT (AIA)

Course Objectives

Enable the students to:

1. Become aware of socio-economic conditions of the farmers and their problems
2. Develop communication skills in using extension teaching methods among farmers and villagers
3. Participate in agro-industrial activities in rural areas

Course Outcomes

The students will be able to:

1. Understand the agricultural ecosystem and farming systems
2. Gain complete knowledge on farmers' problems and situations
3. Disseminate agricultural innovations through farmers' training and mass communication techniques.
4. Become familiar with the government, private and NGO development activities operated in villages.
5. Acquire skills in undertaking socio-economic studies.
Become employable in agro-industries.

21AG2152 PESTS OF CROPS AND STORED GRAINS AND THEIR MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the nature of damage and symptoms of infestation of agricultural, horticultural and storage pests.
2. Gain knowledge on principles and components of Insect Pest Management.
3. Understand the importance of stored produce pest and their management strategies to avoid losses.

Course Outcomes:

The students will be able to:

1. Examine the morphology and taxonomic characteristics of insect pests affecting crops and stored grains.
2. Understand nature and type of damage by different arthropod pests in field, vegetable, fruit and plantation crops, ornamental crops, spices and condiments.
3. Analyze the factors influencing pest occurrence, distribution and control measures.
4. Review the factors affecting losses of stored grain.
5. Analyze the role of various factors in deterioration of grain and their management strategies.
6. Recommend pest management measures to farmers.

21AG2153 MANAGEMENT OF BENEFICIAL INSECTS

Credits 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Understand the importance of beneficial insects and their characteristics.
2. Acquire knowledge on mulberry cultivation and silkworm rearing using innovative techniques.
3. Gain knowledge on bee keeping techniques and mass culturing of predators and parasitoids.

Course Outcomes:

The students will be able to:

1. Relate the scope and importance of beneficial insects.
2. Examine the morphology, biology and behaviour of beneficial insects.
3. Evaluate the common parasitoids and predators used in biological control.
4. Acquire skills on mass multiplication of natural enemies.
5. Correlate innovative techniques on silkworm rearing.
6. Acquire skills on beekeeping for commercial purpose

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21AG2202 FUNDAMENTALS OF PLANT BREEDING

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge on genetic diversity, inheritance, and variation in crops.
2. Understand the concepts in different breeding methods of autogamous, allogamous, and asexually propagated crops.
3. Comprehend intellectual property rights, patenting, plant breeders, and farmers' rights.

Course Outcomes:

The students will be able to:

1. Examine the basic concepts of plant breeding and genetics.
2. Conceptualize the origin and diversity of different crops, components of inheritance, and variations.
3. Apply the knowledge to develop high-yielding crops with better quality.
4. Adopt to produce varieties and hybrids with Host Plant Resistance.
5. Apply the protocols of Intellectual Property Rights and Patenting practically.
6. Acquire skills in plant Breeders and & Farmer's Rights for research and commercial seed production of high-yielding crops.

21AG2203 PRINCIPLES OF SEED TECHNOLOGY

Credits 1:0:2 (1+2)

Course Objectives:

Enable the students to:

1. Discern about seed, grain and seed quality.
2. Precede the concepts of seed certification, seed Act and seed test.
3. Possess the knowledge about the foundation and certified seed production of cereals, pulses, oilseeds, fodder and vegetable crops.

Course Outcomes:

The students will be able to:

1. Speculate the importance of quality seed in agriculture production.
2. Discriminate types of seeds and know seed certification process.
3. Solicit seed production techniques in cereals, pulses, and oilseeds, vegetable and forage seeds.
4. Elucidate seed structure and morphology, physical characteristics of seed.
5. Carry out varietal identification, seed quality assessments tests and seed treatments.
6. Represent the concepts in seed storage and seed marketing.

21AG2204 CROP IMPROVEMENT – I (KHARIF CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Acquire knowledge on diversity, inheritance and genetic variations present in *kharif* crops.
2. Comprehend the different breeding methods in asexually propagated, self and cross pollinated *kharif* crops.
3. Understand hybrid seed production techniques and ideotype concepts in *kharif* crops.

Course Outcomes:

The students will be able to:

1. Review the origin and diversity of different crops.
2. Conceptualize the components of inheritance and various crop improvement techniques.
3. Demonstrate the different breeding techniques for the genetic improvement in *kharif* crops.

4. Evaluate the adaptability, stability, quality parameters, biotic and abiotic stress of various kharif crops.
5. Utilize hybrid seed production techniques in cultivation of kharif crops.
6. Acquire skills on design and layout field experiments to analyze the quality characters of donor parents.

21AG2205 CROP IMPROVEMENT – II (RABI CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Understand the genetic diversity and center of origin for different rabi crops.
2. Comprehend different breeding methods in asexually propagated, self and cross pollinated rabi crops.
3. Review the hybrid seed production techniques and ideotype concepts in rabi crops.

Course Outcomes:

The students will be able to:

1. Conceptualize the origin and diversity of different crops, components of inheritance and various crop improvement techniques.
2. Examine different breeding techniques for the genetic improvement in *rabi* crops.
3. Evaluate the adaptability, stability, quality parameters, biotic and abiotic stress of various rabi crops.
4. Explore the use of hybrid seed production techniques in farming of rabi crops.
5. Analyze the tools for seed production.
6. Apply knowledge to develop Climate resilient crop varieties.

21AG2304 ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge about the natural resources- Renewable and Nonrenewable.
2. Understand the concepts of the Ecosystem, Biodiversity, Environmental pollution and Conservation.
3. Differentiate the Natural and Man- made Disasters and understand their management strategies.

Course Outcomes:

The students will be able to:

1. Identify and distinguish the natural resources- Renewable and Non-renewable
2. Illustrate the concepts of ecosystem and biodiversity
3. Examine and solve environmental pollution issues
4. Plan the conservation strategies
5. Practice Environmental legislation
6. Appraise the disaster management strategies.

21AG2305 RENEWABLE ENERGY AND GREEN TECHNOLOGY

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Understand the different sources of renewable energy.
2. Gain knowledge on utilization of solar, wind and biomass energy.
3. Acquire knowledge on the greenhouse technology.

Course Outcomes:

The students will be able to:

1. Comprehend the contributions of energy sources to agriculture.
2. Design and develop a solar energy storage unit.
3. Apply wind energy for different uses.
4. Suggest techniques for biogas production.
5. Analyse the green energy techniques.

6. Propose production process of biofuels.

21AG2306 MANURES, FERTILIZERS AND SOIL FERTILITY MANAGEMENT

Credits 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the fertility concepts of soil in relation to crop production.
2. Gain knowledge on manures and fertilizers and its role in plant nutrition.
3. Conceptualize the various nutrient recommendation practices.

Course Outcomes:

The students will be able to:

1. Comprehend the concepts of soil fertility and plant nutrition.
2. Evaluate the soil nutrient status and plant nutrient content.
3. Conceptualize the soil nutrient dynamics and plant uptake.
4. Appreciate the importance of manures and fertilizers in crop production.
5. Suggest nutrient recommendation based on soil fertility.
6. Apply advanced techniques in soil fertility management.

21AG2307 PROBLEMATIC SOILS AND THEIR MANAGEMENT

Credits: 2:0:0 (2+0)

Course Objectives:

Enable the students to:

1. Gain knowledge on waste lands, problematic soils and their management practices
2. Understand the quality standards of irrigation water
3. Conceptualize the remote sensing and GIS techniques in management of problematic soils.

Course Outcomes:

The students will be able to:

1. Identify the waste lands and problematic soils and recommend appropriate management practices.
2. Analyze the suitability of water for irrigation based on quality standards.
3. Apply remote sensing and GIS techniques in the management of problematic soils.
4. Suggest suitable bioremediation measures for the problematic soils.
5. Evaluate the land based on Land Capability and Suitability Classes.
6. Assess the suitability of problematic soils in various agro-ecosystems.

21AG2352 DISEASES OF FIELD AND HORTICULTURAL CROPS AND THEIR MANAGEMENT - I

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the student to:

1. Understand various diseases of field and horticultural crops and their causal organisms.
2. Identify the symptoms associated with the disease and to understand the etiology and disease cycle.
3. Acquire knowledge on various integrated management practices.

Course Outcomes:

The student will be able to:

1. Conceptualize various plant pathological terms and basic concepts of important plant diseases.
2. Examine the disease symptoms of various plant diseases of field and horticultural crops.
3. Correlate host pathogen interaction with disease development in field and horticultural crops.
4. Evaluate the prevalence, epidemiology and factors affecting disease development.
5. Comprehend disease cycle of plant pathogens.
6. Acquire skills for integrated management of field and horticultural crops.

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21AG2353 DISEASES OF FIELD AND HORTICULTURAL CROPS AND THEIR MANAGEMENT – II

Credits: 2:0:1 (2+1)

Enable the student to:

1. Gain knowledge on major diseases of field and horticultural crops.
2. Understand the causal organisms of plant diseases, etiology and disease cycle.
3. Conceptualize integrated management practices to be followed for curtailing plant pathogens.

Course Outcomes:

The student will be able to:

1. Correlate the various plant pathological terms with basic concepts of important plant diseases.
2. Identify the disease symptoms of various plant diseases of field and horticultural crops.
3. Review the impact of host pathogen interaction on disease development in field and horticultural crops.
4. Evaluate the prevalence, epidemiology and factors affecting disease development.
5. Comprehend disease cycle of plant pathogens.
6. Acquire skills on management practices for diseases of field and horticultural crops.

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8. Tripathi D.P. 2011. Introductory Plant Pathology, Kalyani publishers, New Delhi New Delhi, 380p

21AG2354 PRINCIPLES OF INTEGRATED PEST AND DISEASE MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the various categories of economically important pest and diseases and their identification and diagnosis methods.
2. Acquire knowledge on principles of insect pest and disease management, including concepts, importance, tools and constraints of IPM.
3. Gain knowledge on computation of ETL, AESA based IPM and implementing IPM programs.

Course Outcomes:

The students will be able to:

1. Review the important concepts and principles of integrated pest and disease management practices.
2. Analyze and demonstrate the various tools of IPM - Cultural, Mechanical, Physical, Biological, Legal and Chemical control.
3. Conceptualize the Integrated pest and disease management strategies.
4. Examine the pest outbreak through pest monitoring, forecasting and surveillance methods.
5. Appriase farmers about the importance of IPM and help them to implement the suitable IPM practices based on AESA.
6. Evaluate the political, social, and legal implication of implemented IPM.

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21AG2401 LIVESTOCK AND POULTRY MANAGEMENT

Credits 3:0:1 (3+1)

Course objectives:

Enable the students to:

1. Understand the importance of farm animals in a farming ecosystem
2. Familiarize with the important traits of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry.
3. Improvement, management, prevention and control of diseases of livestock and poultry.

Course Outcomes:

The students will be able to:

1. Demonstrate the importance of farm animals in the rural economy.
2. Examine the traits of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry.
3. Select improved breeds of livestock and poultry.
4. Analyze the nutritional value of feed rations for farm animals.
5. Design the animal housing plan in relation to the requirements.
6. Recommend practices for prevention and control of animal diseases.

21AG2452 FARM MACHINERY AND POWER

Credits 1:0:1 (1+1)

Course objectives:

Enable the students to:

1. Understand the importance and scope of farm mechanisation in India.
2. Acquire knowledge on engine systems.
3. Gain knowledge on utilization of various farm implements and machinery.

Course Outcomes:

The students will be able to:

1. Familiarize with the components of IC engine.
2. Demonstrate the operation and maintenance of tractor.
3. Apply the working principle of tillage, sowing and planting equipments.
4. Examine working of various intercultivation equipments.
5. Operate various plant protection equipments.
6. Demonstrate the working of harvesting and threshing machinery.

21AG2453 PROTECTED CULTIVATION AND SECONDARY AGRICULTURE

Credits 1:0:1 (1+1)

Course objectives:

Enable the students to:

1. Understand the basics of protected cultivation.
2. Acquire knowledge on different engineering properties.
3. Gain skill on utilization of dryers and conveyors.

Course Outcomes:**The students will be able to:**

1. Develop a low-cost green house.
2. Comprehend the plant responses to greenhouse environment.
3. Estimate the cost benefit economics of protected cultivation.
4. Outline engineering properties of food materials.
5. Demonstrate the working of commercial grain dryer.
6. Suggest suitable material handling equipment.

21AG2551 AGRI INFORMATICS**Credit 1:0:1 (1+1)****Course Objectives:****Enable the students to:**

1. Understand the application of IT in agriculture using computerized models.
2. Acquire knowledge on precision agriculture using geospatial technology.
3. Familiarize with the Decision Support Systems (DSS) and soil information for agricultural applications.

Course Outcomes:**The students will be able to:**

1. Demonstrate the use of information, communication and technology (ICT) in agriculture.
2. Adopt GIS and GPS systems in precision agriculture.
3. Develop computerized models to understand plant growth process.
4. Utilize smart phones in farm advisory farm pricing and post-harvest management.
5. Manage input requirements for crops and animals.
6. Apply Agriculture Expert system and Soil Information Systems for a firm decision.

21AG2552 INTELLECTUAL PROPERTY RIGHTS**Credits 1:0:0 (1+0)****Course Objectives:****Enable the students to:**

1. Define and distinguish several forms of intellectual properties (IPs) and their functions in contributing to organizational competitiveness.
2. Acquire exposure to intellectual property law and an understanding of real-world IPM practices.
3. Comprehend and assess various IP management (IPM) techniques, and define how forward-thinking firms conceive, implement, and manage IPM programmes.

Course Outcomes:**The students will be able to:**

1. Identify various types of Intellectual Property (IPs), ownership rights, scope of protection, and methods for creating and extracting value from IP.
2. Anticipate and critically examine ideas about the evolution and reform of intellectual property rights institutions, and their potential impact on creativity and innovation.
3. Recognize the value of intellectual property (IP) in enterprises across industries to achieve product and technology development goals.
4. Assess ownership rights and marketing protection under intellectual property law as they pertain to information, ideas, new products, and product marketing.
5. Identify IP-infringing behaviors, remedies available to IP owners, and steps to be taken to prevent infringement of intellectual rights in product and technology development.
6. Encourage the effective, appropriate, and balanced protection and enforcement of intellectual property rights on biological conservation.

21HO1251 FUNDAMENTALS OF HORTICULTURE**Credits 2:0:1 (2+1)****Course Objectives:****Enable student to:**

1. Understand the importance, scope and classification of horticultural crops.
2. Gain skills on propagation and nursery techniques of horticultural crops.

3. Familiarize with the basics of orchard layout, establishment and management.

Course Outcomes:**The students will be able to:**

1. Relate the classification of Agroclimatic zones with congeniality for production of horticultural crops
2. Analyze the various factors of growth and development with production of horticultural crops
3. Apply the concepts of layout of kitchen and nutritional garden
4. Adopt propagation techniques for commercial nursery enterprises
5. Apply the concepts of training, pruning, fruitset, and regulation of bearing in horticultural crops
6. Demonstrate orchard establishment and management

21HO1270 PRODUCTION TECHNOLOGY FOR FRUIT AND PLANTATION CROPS**Credits 1:0:1 (1+1)****Course Objectives:****Enable student to:**

1. Understand commercial importance and scope of fruit and plantation crops in India.
2. Gain knowledge on production technology and processing of fruit crops.
3. Gain knowledge on production technology and processing of plantation crops.

Course Outcomes:**The students will be able to:**

1. Analyze the industrial potential of fruit and plantation crops.
2. Develop skills on propagation methods of fruit and plantation crops.
3. Demonstrate knowledge gained on use of growth regulators in fruit crops.
4. Apply the knowledge gained in production technologies of fruit and plantation crops.
5. Develop entrepreneurial skills in processing of fruit and plantation crops.
6. Get equipped in plantation and orchard management.

21HO2271 PRODUCTION TECHNOLOGY FOR VEGETABLES AND SPICES**Credits 1:0:1 (1+1)****Course Objectives:****Enable student to:**

1. Understand the nutritional quality and importance of different groups of vegetables and spices.
2. Gain knowledge on production technology and physiological disorders of vegetable crops.
3. Gain knowledge on production technology and processing of spice crops.

Course Outcomes:**The students will be able to:**

1. Get sensitized on the role of vegetables and spices in human nutrition.
2. Acquire knowledge on varietal wealth of vegetable and spice crops.
3. Equipped to identify and manage physiological disorders of vegetable crops.
4. Demonstrate skills in nursery management and production technology of vegetable and spices.
5. Analyze the critical stages of harvesting of vegetables and spice crops.
6. Apply knowledge on processing technology of spice crops for gainful employment.

21HO2272 PRODUCTION TECHNOLOGY FOR ORNAMENTAL CROPS, MAP AND LANDSCAPING**Credits: 1:0:1 (1+1)****Course Objectives:****Enable student to:**

1. Identify and familiarize with flower crops, medicinal and aromatic plants and ornamental plants for landscaping.
2. Gain knowledge on production technology of flower crops, medicinal and aromatic plants and ornamentals.
3. Get trained on harvesting, post-harvest handling and processing of flower and medicinal crops.

Course Outcomes:**The students will be able to:**

1. Apply knowledge in cut flower production under protected cultivation for gainful employment or entrepreneurship.
2. Demonstrate skills for cut and loose flower production under open condition.
3. Apply skills in identification and conservation of medicinal and aromatic plants and analyze their application.
4. Acquire skills in processing of medicinal and aromatic plants and post-harvest handling of cut and loose flowers
5. Exploit knowledge on use of plants and trees for landscaping under different conditions
6. Design and layout different styles of gardens

21HO2273 POST-HARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES

Credits 1:0:1 (1+1)

Course Objectives:

Enable student to:

1. Understand the scope and importance of post-harvest technology
2. Comprehend the post-harvest physiology of fruits and vegetables
3. Gain knowledge on principles, methods and standards of preservation and value addition process of fruits and vegetables

Course Outcomes:

The students will be able to:

1. Analyze the causes for post-harvest losses and ways to minimize
2. Apply various preservation methods for extension of post-harvest life.
3. Demonstrate skills for commercial exploitation of value-added products
4. Acquire entrepreneurial skills on visiting the commercial food processing industries
5. Recommend suitable storage and packaging methods
6. Acquire knowledge on the food standards and safety regulations

21HO2274 PRINCIPLES OF FOOD SCIENCE AND NUTRITION

Credit 2:0:0 (2+0)

Course Objectives:

Enable the students to:

1. Understand the basic concepts of food science, food chemistry and food microbiology.
2. Gain knowledge about the principles and methods of food processing and microbial food spoilers.
3. Acquire knowledge about Malnutrition, nutritional disorders and planning a balanced/modified diet.

Course Outcomes:

The students will be able to:

1. Comprehend the concepts of food science.
2. Enumerate and describe food composition and food chemistry.
3. Demonstrate the principles and methods of food processing.
4. Analyze the methods to control microbes and preserve food.
5. Identify nutritional disorders.
6. Design balanced/modified diet to meet consumer needs.

22AG2013 GEOINFORMATICS, NANO-TECHNOLOGY AND PRECISION FARMING

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Understand the significance of precision agriculture
2. Gain knowledge on Geoinformatics and its application in precision farming
3. Acquire knowledge on Nanotechnology and its role in precision farming

Course Outcomes:

The students will be able to:

1. Demonstrate the concepts of precision farming.
2. Make use of Unmanned Aerial Vehicle (UAV) in farm operations.

3. Apply the Geoinformatic principles and the use of GIS, GPS, Sensors and Remote Sensing technologies in agriculture.
4. Relate the use of various Crop Simulation Models in crop production.
5. Apply the STCR approach for optimizing the fertilizer inputs in precision farming.
6. Acquire skills on nanotechnology and its uses for scaling-up farm productivity.

22AG2056 STATISTICAL METHODS

Credits: 1:0:1(1+1)

Course objectives:

Enable the students to:

1. Acquire the knowledge of statistical methods.
2. Understand the process of using statistics in Agricultural problems.
3. Develop the skills of problem solving in Agriculture.

Course outcomes:

The students will be able to:

1. Identify the applications of statistics to Agriculture.
2. Measure the central tendency and dispersion of Data.
3. Recognize the different probability distributions.
4. Utilize testing tools to verify hypothesis.
5. Design the experiments and make appropriate decisions.
6. Apply the skills of sampling in problem solving.

22AG2108 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS COMMUNICATION

Credits: 1:0:1 (1+1)

Course Objectives:

Enable the students to:

1. Gain entrepreneurial spirit and orientation towards becoming an entrepreneur
2. Understand the Agri-business opportunities that are commercially successful and the procedures involved in start-ups
3. Acquire knowledge on the art and science of business plan and project formulation

Course Outcomes:

The students will be able to:

1. Distinguish different entrepreneurial traits and skills
2. Analyze agribusiness opportunities open for agriculture graduates
3. Apply the leadership skills to get financial support for start-ups
4. Demonstrate the impact of economic reforms in agri-business
5. Perform SWOT analysis of an entity for any prospective agribusiness/ideas
6. Formulate business proposals for successful implementation of business plans

22HO2275 LANDSCAPING- Elective Course 1

Credits: 2:0:1 (2+1)

Course Objectives:

Enable student to:

1. Identify and familiarize with different ornamental plants for indoor and outdoor landscaping
2. Plan, design, Layout, construct and maintain different styles of landscaping
3. Gain exposure in specialty gardens, flower arrangement and bonsai making

Course Outcomes:

The students will be able to:

1. Apply knowledge gained in identification of landscape plants in garden design
2. Develop design skills using landscaping software.
3. Establish lawns using different types of grasses for different conditions.
4. Establish specialty gardens such as vertical gardens, terrarium, bonsai, xeriscaping, rock garden.
5. Set up nursery for landscape plants.
6. Exploit skills acquired in flower arrangement for commercial enterprise.

22AG2308 AGROCHEMICALS- Elective Course 3

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to

1. Acquire knowledge on the basics of agrochemicals and its role in agriculture.
2. Ascertain the mode of action of agrochemicals.
3. Estimate the chemical composition of agrochemicals.

Course Outcomes:

The students will be able to:

1. Appraise the role of agrochemicals in sustainable agriculture.
2. Classify the agrochemicals and elucidate their mode of action.
3. Demonstrate the manufacturing process of fertilizers.
4. Provide marketing strategies and logistics of agrochemicals.
4. Analyse the chemical composition of agrochemicals.
5. Emphasize the importance of bio pesticides for sustainable agriculture.
6. Evaluate need-based recommendation for various crops.

23AG2012 SYSTEM SIMULATION AND AGRO ADVISORY

Credits: 2:0:1 (2+1)

Course Objectives

Enable the students to:

1. Understand the crop models, concepts and techniques in agriculture
2. Acquires skill on weather forecasting, methods, tools and techniques in agriculture
3. Gain knowledge on agro-advisories and understand their effective dissemination.

Course Outcomes

The students will be able to:

1. Define the critical phases in the pheno-phasic development of important field crops.
2. Assess and differentiate various crop simulation models.
3. Apply crop simulation models and their concepts on growth and yield of field crops.
4. Infer crop responses to weather elements, develop crop weather calendars and skills in crop weather forecasting.
5. Develop and disseminate effective agro advisories for different cropping systems.
6. Use of different channels for disseminating agro-advisories to farmers.

23AG2057 AGRI-BUSINESS MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the basic concepts -marketing tools and techniques of agri-business management.
2. Familiarize with the Organisational behaviour of Agri-business models.
3. Acquire knowledge on Principles governing the financial management in Agri -business.

Course Outcomes:

The students will be able to:

1. Decipher the micro and macro environmental forces and their impact on agri-business.
2. Improve capabilities in financial and investment decisions.
3. Conceive, initiate and develop new projects leading to new startups / individual business entities.
4. Apply the knowledge of the basic concepts in developing an efficient Marketing Information System.
5. Overcome the issues and challenges existing in rural markets.
6. Acquire the latest marketing practices defined in trade regime's, different WTO laws and international trading in agriculture.

23AG2109 EXPERIENTIAL LEARNING PROGRAM-SEED PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives:

Enable the students to:

1. Acquire skills in the process of seed production.
2. Develop crops and follow standards required for seed certification.
3. Demonstrate quality certified seed production.

Course Outcomes:

The students will be able to:

1. Acquire skills in quality seed production.
2. Adopt the prescribed seed standards fixed by International Seed Testing Association (ISTA).
3. Apply the quality parameters prescribed in seed testing.
4. Examine the protocols and procedures followed in certified seed production.
5. Practice the techniques of seed processing, packaging and labelling.
6. Identify the marketing channels and challenges in seed production and gain the confidence to initiate Seed Business Ventures.

23AG2110 EXPERIENTIAL LEARNING PROGRAM-SOIL, PLANT, AND WATER TESTING SERVICES

Credits (0+10)

Course Objectives:

Enable the students to:

1. Infer the fertility status of the soil based on its physical and chemical properties and soil nutrient content.
2. Determine the suitability of irrigation water based on its quality standards.
3. Prepare soil health cards and water test reports.

Course Outcomes:

The students will be able to:

1. Collect and process representative soil, irrigation water and plant samples for analysis.
2. Evaluate the macro and micro nutrient fertility status of the soil through analysis.
3. Prepare soil health cards and provide nutrient recommendation to crops based on soil fertility status.
4. Estimate the macronutrient contents in plant samples.
5. Infer the suitability of water for irrigation and prepare water test reports.
6. Start up a soil and water testing unit and advisory centre.

23AG2111 EXPERIENTIAL LEARNING PROGRAM-ORGANIC PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives:

Enable the students to:

1. Understand the organic production protocols and requirements for certification.
2. Gain knowledge on organic inputs and crop production through hands-on experience.
3. Develop project management skills in organic inputs and crop production.

Course Outcomes:

The students will be able to:

1. Demonstrate the skill in the production techniques of various organic manures, bio-pesticides and bio-control agents.
2. Gain insight on protocols for organic crop production technologies from seed to seed.
3. Acquire skills in the use and application of various organic manures, bio-pesticides and bio-control agents.
4. Earn hands on experience in vermicompost production and organic green leafy vegetable cultivation.
5. Independently guide farmers on organic certification protocols and marketing.
6. Build confidence to initiate startup ventures in organic crop production.

23AG2112 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL FLORICULTURE AND LANDSCAPING

Credits (0+10)

Course Objectives:

Enable student to:

1. Promote professional skills on propagation of commercial ornamental crops
2. To build confidence for establishment of commercial floriculture units and landscape gardens
3. Analyze the cost economics for sustainability of floriculture and landscaping units

Course Outcomes

The students will be able to:

1. Mass produce varieties of ornamental and flower crops and practice hardening of tissue culture plants
2. Cultivate short duration flower crops under open and protected conditions
3. Design and develop landscape gardens.
4. Develop value-added products using fresh and dry flowers.
5. Gain expertise to establish and manage a commercial ornamental nursery unit
6. Acquire marketing skills and attain business acumen for sustainability of the commercial venture

23AG2113 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL NURSERY MANAGEMENT AND PROTECTED CULTIVATION

Credits (0+10)

Course Objectives:

Enable student to:

1. Promote professional skills on propagation and establishment of commercial horticultural nursery.
2. Gain knowledge on successful cultivation of high-value vegetable and flower crops under protected structures.
3. Analyze the cost economics for sustainability of Horticulture nursery and polyhouse cultivation.

Course Outcomes:

The students will be able to:

1. Mass produce elite varieties of vegetable, fruit, plantation and ornamental trees
2. Gain expertise in procurement of inputs including seeds, mother plants, pots and potting media and other accessories in a cost-effective manner
3. Grow short duration vegetables and flower crops under protected structures
4. Gain expertise to establish and manage a commercial horticultural nursery
5. Develop business networking and entrepreneurial skills for promoting sales of nursery plants.
6. Act as a consultant for different nursery structures and nursery establishment

23AG2114 EXPERIENTIAL LEARNING PROGRAM-PRODUCTION TECHNOLOGY OF BIOFERTILIZER

Credits (0+10)

Course Objectives:

Enable the students to:

1. Gain hands on experience on biofertilizer production.
2. Acquire knowledge on maintenance of aseptic conditions, laboratory equipment and subculturing various bioinoculants.
3. Familiarize with the Quality control and Standards of biofertilizers for sustainable crop production.

Course Outcomes:

The students will be able to:

1. Isolate and conserve the efficient strains of microorganisms for the improvement of plant growth and soil health.
2. Familiarize with the routine handling of equipments used in biofertilizer production unit.
3. Acquire hands on experience on commercial production technologies of various biofertilizer formulations.
4. Practise the skills and procedures in quality control of biofertilizers.
5. Apply the bio-inoculants as per package of practices recommended in organic farming and crop production.

6. Attain technical, marketing and entrepreneurial skills to establish a biofertilizer startup\ unit.

23AG2115 EXPERIENTIAL LEARNING PROGRAM-MUSHROOM CULTIVATION TECHNOLOGY

Credits (0+10)

Course Objectives:

Enable the students to:

1. Acquire knowledge on importance of mushrooms and its nutritional value.
2. Facilitate hands on training to the students for the preparation of beds for different varieties of mushroom and spawn production.
3. Understand product diversification, value addition of mushrooms and cost economics of mushroom cultivation.

Course outcomes:

The students will be able to:

1. Identify and differentiate edible and poisonous mushrooms.
2. Develop skills on cultivation of different types of edible mushrooms and spawn production.
3. Review various biotic and abiotic factors that reduce the yield of mushroom and manage them.
4. Conceptualize value-added products of mushrooms.
5. Analyse market intelligence and support systems to realise maximum yield and profit.
6. Acquire entrepreneurial skills leading to start ups and business ventures.

23AG2116 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL BEEKEEPING

Credits (0+10)

Course objectives:

Enable the students to:

1. Understand the various techniques of bee keeping, types of honeybees, apiary management, nutraceutical properties of honey and by-products, pests and diseases management.
2. Acquire knowledge on migratory/ stationary bee keeping, harvesting and processing of honey, product diversification and value addition of honey and beeswax, quality control, standards and marketing.
3. Gain knowledge on beekeeping entrepreneurship - to involve in honey marketing business for self-employment.

Course outcomes:

The students will be able to:

1. Examine the bee biology, behaviour and rearing of bees.
2. Acquire skills on handling beekeeping equipment such as hives, honey extractor and tools.
3. Analyze their experience in beehive management.
4. Acquire skills on in extraction, preservation, marketing and quality assessment of honey and other by- products of honeybee.
5. Apply migratory beekeeping for commercial honey collection.
6. Evaluate value added products for commercialization.

23AG2117 EXPERIENTIAL LEARNING PROGRAM-AGRIBUSINESS MANAGEMENT

Credits (0+10)

Course Objectives

Enable the students to:

1. Assess the supply, demand, and price trends of agricultural commodities.
2. Create an app to launch a digital platform for the sale of agricultural commodities.
3. Pursue a career as a business consultant

Course Outcomes:

The students will be able to:

1. Carry out market survey and understand consumer behaviour, demand and supply of agricultural commodities and price trends
2. Create an app to launch a digital platform for the sale of agricultural commodities.
3. Design a customized digital marketing plan.
4. Gain the necessary entrepreneurial skills to successfully initiate a start- up /agri- business venture.

5. Develop skills in commodity trading, website design, creation and hosting, and use of social media platforms for marketing.
6. Prepare a business project proposal to financial institutions.

23AG2118 EXPERIENTIAL LEARNING PROGRAM-AGRICULTURAL INFORMATION SUPPORT SERVICES

Credits (0+10)

Course Objectives:

Enable the students to:

1. Gain knowledge on Information and Communication Technologies (ICTs) based agriculture information services to stakeholders.
2. Understand the Content Management Systems (CMS) for dissemination of weather information and advisory services.
3. Gain Hands-on training on Agriculture Expert System and Decision Support System.

Course Outcomes:

The students will be able to:

1. Practice with tools for agriculture information dissemination.
2. Develop websites for agriculture information services to agriculture stakeholders.
3. Design Mobile Apps for agriculture information exchange.
4. Create applications for weather information exchange with farmers.
5. Developing and testing farmer-friendly agriculture expert systems.
6. Apply Decision Support system in smart farming.

23AG2119 EXPERIENTIAL LEARNING PROGRAM-BROILER PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives:

Enable the students to:

1. Comprehend the importance of broiler production as a business enterprise.
2. Design a broiler housing unit.
3. Manage a commercial broiler unit.

Course Outcomes:

The students will be able to:

1. Demonstrate the potential of broiler production as a business enterprise.
2. Design and develop a poultry house.
3. Develop brooding of chicks and ensure optimal environmental conditions.
4. Practise scientific feeding program based on the growth stages of chick and maintain healthy and hygienic environment in the farm.
5. Apply practices for prevention and control of common diseases in a poultry farm.
6. Analyse market trends and develop appropriate sales strategies.

Project preparation and planning based on visit to commercial broiler farms. Preparation of project module based on source of finance, market information, assessment of fixed and working capital requirements, identification of sources for procurement of chicks, feed and other raw materials. Setting up a broiler farming unit with suitable necessities. Planning and execution of management practices of poultry farm viz. Site selection and preparation of poultry house, different housing regimes, fumigation, incubation, brooding, debeaking and sanitation, hatching of eggs, management of chicks, management of pullets and growers, management of broilers, selection and culling, feed and feed formulation. Prevention and control of diseases: medication and vaccination. Biosecurity measures: processing of broilers, record maintenance, integration method of broilers marketing, marketing channels in broilers. Economics of broiler farming.

23AG2120 EXPERIENTIAL LEARNING PROGRAM-FOOD PROCESSING

Credits (0+10)

Course Objectives:

Enable student to:

1. Practice value addition of fruits, vegetables, and cereals.
2. Develop professional skills in operation and maintenance of processing equipment and machineries

3. Apply skills in quality control and assurance of processed foods.

Course Outcomes:**The students will be able to:**

1. Develop and produce value-added products of fruits, vegetables and cereals.
2. Operate and use post-harvest machineries, instruments, tools and equipment.
3. Gain expertise in packaging, branding, labelling and pricing of the food products.
4. Analyze the cost economics and propose bankable projects
5. Develop entrepreneurial skills for marketing of processed foods.
6. Independently establish and manage a food processing unit.

Guidelines for setting up a processing unit, acquaintance with equipment used in food processing units, analysis of quality parameters in fruits and vegetables. Post-harvest treatments in fruits and vegetables, sorting, grading and sizing of fruits and vegetables, primary processing, secondary processing, packaging of food materials, Cold preservation by lyophilization. Preparation of dehydrated fruits and veggies, fruit bars Value addition: preparation of fermented beverages - wine and vinegar and preparation of non-fermented beverages – RTS beverage, nectar and squash, Preparation of intermediate moisture foods – jam, jelly and marmalade. Preservation by sugar – candies, Preservation by salt – pickle, chutneys and sauce, Minimal processing of fruits and vegetables. Preparation of baked products – cakes, cookies and bread, Visit to food processing units.

23AG2121 EXPERIENTIAL LEARNING PROGRAM-PRODUCTION TECHNOLOGY OF BIOCONTROL AGENTS

Credits (0+10)**Course objectives:****Enable the students to:**

1. Understand the significance, role and mode of action of bio-agents used in plant disease and pest management.
2. Acquire knowledge on mass production technologies for fungal, bacterial bio-control agents, predators and parasitoids.
3. Devise strategies for quality control, field application, regulation, cost analysis and marketing of bio-agents.

Course outcomes:**The students will be able to:**

1. Analyse the use of bio-agents for the management of pest and disease in field conditions.
2. Formulate mass production and quality control protocols of bio-agents.
3. Conceptualize the mode of action, predatory potential, parasitism of bio-agents and its scheduled application at various stages of infestation.
4. Examine the procedures for registration of bio-agents as per the statutory guidelines.
5. Evaluate and adopt different market intelligence and channels for production and promotion of bio-control agents.
6. Acquire skills to develop start-ups of bio-control units.

Students will learn about rearing of host insect *Corcyra cephalonica*. Rearing of egg parasitoid-sterilizing the host eggs and parasitization, Tricho card preparation and storing. Rearing of larval parasitoid Bracon and *Goniozus nephantidis* – sandwich method. Mass production of predator *Chrysoperla carnea*. Isolation, characterization, screening and pure culture establishment of bio-agents. Commercial mass production of bio-agents. Quality analysis of bio-agents. Testing the final product in small-scale level. Storage, marketing and cost analysis of bio-agents. Exposure visit to bio-control units.

23AG2122 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL SERICULTURE

Credits: (0+ 10)**Course objectives:****Enable the students to:**

1. Understand the principles and techniques of Mulberry and Non-Mulberry Silkworm Rearing.
2. Gain knowledge on cocoon productivity and prevention of silkworm diseases.
3. Acquire knowledge on entrepreneurial skills and practices in Sericulture.

Course outcomes:**The students will be able to:**

1. Relate the different silkworm races available in India.
2. Analyze the suitable cultivation methods of Mulberry, Eri and Tassar silkworms.
3. Acquire skills on establishment of silkworm rearing house, handling of rearing appliances, application of disinfectants and harvesting of cocoons.
4. Evaluate the management practices for pests and diseases in mulberry silkworm and mulberry crop.
5. Acquire skills on establishing scientific grainage to produce healthy Disease Free Layings (DFLs).
6. Apply entrepreneurial skills for commercial silkworm rearing and marketing.

23AG2123 EXPERIENTIAL LEARNING PROGRAM-CROP PRODUCTION AND PROCESSING OF TURMERIC**Credits (0+10)****Course Objectives:****Enable student to:**

1. Gain knowledge on production technologies of turmeric from seed to harvest.
2. Practice grading, curing and value-addition of turmeric.
3. Understand the cost economics of production, processing and value-addition of turmeric.

Course Outcomes:**The students will be able to:**

1. Demonstrate propagation and planting methods of turmeric.
2. Adopt all recommended package of practices for scientific turmeric production
3. Acquire knowledge on improved varieties and recommend for cultivation.
4. Demonstrate grading and curing of turmeric by using equipment and machinery
5. Develop entrepreneurship skills for value addition in extraction of turmeric oil and oleoresin.
6. Apply skills acquired to establish commercial turmeric production and processing unit.

Soil analysis - physical, chemical and biological properties. Reclamation if any needed. Mobilization of organic manures and inorganic manures – procurement of seed rhizome – preparation for sowing. Field preparation – ridges and furrows – basal application of manures – sowing – optimum size of rhizomes – life irrigation and further irrigations – hand weeding – earthing up – top dressing – plant protection measures. Harvest through digging fork or tractor and separation of finger and mother rhizome and sorting – storage of rhizomes – primary processing and secondary processing – curing – boiling – drying – polishing – packaging, monitoring of storage pest and diseases. Extraction of essential oil – oleoresin – curcumin – quality parameters for oil and turmeric powder. Development, preparation and sales of value-added products of turmeric. Marketing of turmeric based on price forecast, working out cost-benefit analysis, report writing, visit to turmeric-growing/processing areas.

23AG2124 EXPERIENTIAL LEARNING PROGRAM-CROP PRODUCTION AND STORAGE OF SMALL ONION**Credits (0+ 10)****Course Objectives:****Enable student to:**

1. Gain knowledge on production technologies of small onion from seed to harvest.
2. Familiarize with economic and efficient storage methods of small onion.
3. Understand the economics of production and storage of small onion.

Course Outcomes**The students will be able to:**

1. Identify and adopt quality planting material and improved varieties for small onion production.
2. Apply recommended and improved cultivation practices for producing quality onion bulbs.
3. Demonstrate efficient harvesting and storage techniques of small onion.
4. Apply skills gained to execute post-harvest handling procedures like cleaning, sorting and grading of small onion.
5. Develop marketing strategies to maximize profit in small onion cultivation.
6. Analyze and compute the cost-benefit ratio of small onion production.

Soil analysis – physical, chemical and biological properties, soil nutrient status. Seed material – selection, cleaning and grading. Field preparation – ploughing, levelling, preparation of beds, application of basal dose, sowing, spacing requirement, irrigation Intercultural operations – weeding, irrigation, gap filling, top dressing, earthing up, and plant protection activities. Assessment of crop maturity and harvesting. Cleaning, grading, sorting, storage and post- harvest management. Monitoring of storage pests and diseases, marketing based on price forecast, working out cost-benefit analysis, report writing, visit to local onion-growing areas.

23AG2125 EXPERIENTIAL LEARNING PROGRAM-QUAIL PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives

Enable the students to:

1. Comprehend the importance of quail farming.
2. Identify the improved egg type and feather type breeds of quails.
3. Manage commercial quail farms.

Course Outcomes

The students will be able to:

1. Demonstrate the significance of quail farming.
2. Design the housing of quails.
3. Develop the brooding of chicks and ensure optimal environmental conditions.
4. Practise scientific feeding program based on the growth stages of chicks.
5. Maintain healthy and hygienic environment in and around the farm.
6. Apply practices for prevention and control of common diseases in quail farm.

23AG2126 AGRICULTURAL JOURNALISM

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the principles, ethics and practices on agriculture news dissemination.
2. Develop skill in newsgathering, writing style and language for agriculture leaflets, pamphlets, newspaper, magazine, and mass media including various online digital platforms.
3. Gain knowledge on multimedia tools for illustrating agricultural stories and editorial mechanics.

Course Outcomes:

The students will be able to:

1. Efficiently gather agricultural news and updates.
2. Develop competency in writing, editing and content development of agri-news.
3. Apply editorial mechanics such as proof reading, copy editing and develop captivating headlines / titles.
4. Individually develop write-ups, news clippings and presentations for news media such as newspapers, magazines and electronic media.
5. Update on the latest journalistic approaches, style and presentations.
6. Develop skills in recent advances in photography, videography, post-processing and editorial decision making.

23AG2205 COMMERCIAL PLANT BREEDING

Credits 1:0:2 (1+2)

Course Objectives:

Enable the students to:

1. Understand the development of lines, hybrids and seed production.
2. Gain knowledge on alternative approaches for the development of lines and cultivars.
3. Acquire knowledge on Intellectual Property Rights, DUS Testing and variety registration.

Course Outcomes:

The students will be able to:

1. Explain plant reproduction and their floral biology.
2. Demonstrate the techniques of development and maintenance of breeding lines.
3. Apply the breeding methods to produce marketable hybrid seeds of various crops.
4. Analyze the tools and techniques for optimizing quality seed production.

5. Develop alternative strategies for the development of breeding lines.
6. Evaluate DUS testing and quality seed testing for commercial hybrid seeds.

23AG2309 BIOPESTICIDES & BIOFERTILIZERS

Credits 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the significance and scope of biopesticides and biofertilizers in sustainable farming.
2. Familiarize with the production technologies of various bio-inoculants for soil and plant health.
3. Gain knowledge on Quality control, Statutory Regulations and Marketing of biopesticides and biofertilizers.

Course Outcomes:

The students will be able to:

1. Differentiate bacteria, fungi and algae based bio-inoculants (biopesticides and biofertilizers).
2. Apply the concepts and mechanisms of plant growth promoting traits of bio-inoculants.
3. Make use of the established plant based pesticidal formulations in integrated farming.
4. Acquire hands on experience in production of various bio-inoculants and their targeted delivery.
5. Ensure registration and adoption of all the statutory quality control guidelines of regulatory bodies.
6. Analyse the market strategies and impediments in promoting bio-inoculants.

23AG2454 PROTECTED CULTIVATION

Credits 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the basics of protected cultivation.
2. Gain knowledge on requirements of cultivation in protected situations.
3. Familiarize with different techniques involved in protected cultivation.

Course Outcomes:

The students will be able to:

1. Plan and design of low-cost greenhouses.
2. Use foggers to create humidity in air at different environmental conditions.
3. Monitor plant growth in Greenhouse using wireless sensors.
4. Regulation and maintenance of devices through IoT.
5. Design computer-based control and remote operation of drip irrigation and fertigation in greenhouse.
6. Hands on experience in understanding greenhouse effect and off-season production of crops.

2) List of Elective Courses with Revised Course Codes

S. No.	Discipline	Existing Course Code	Revised Course Code	Name of the Course	Credits
1.	HOR	23AG2275	23HO2276	Food Safety and Standards	3(2+1)
2.	HOR	23AG2276	23HO2277	Micro propagation Technologies	3(1+2)
3.	HOR	23AG2277	23HO2278	Hi-tech. Horticulture	3(2+1)

23HO2276 FOOD SAFETY AND STANDARDS

Credits: 2:0:1 (2+1)

Course Objectives

Enable the students to:

1. Understand Food safety, risks and hazards.
2. Gain knowledge on Food hygiene, sanitation and food safety management tools- PRPs, GHPs, GMPs, SSOPs, HACCP.
3. Familiarize with Laws, quality standards, packaging, and labelling of food products.

Course Outcomes:
The students will be able to:

1. Apply the various practices and protocols of hygiene and sanitation in food service establishments.
2. Demonstrate the factors affecting food safety, risks and types of hazards.
3. Acquire hands-on experience and skills in overcoming food safety hazards.
4. Familiarize with food safety management tools.
5. Update on newer technologies and standards of food safety.
6. Adopt the relevant food laws, standards and apply the regulatory regimes.

23HO2277 MICRO PROPAGATION TECHNOLOGIES
Credits: 1:0:2 (1+2)
Course Objectives:
Enable the students to:

1. Understand the basic principles and applications of micropropagation techniques.
2. Familiarize laboratory hygiene and protocols, media preparation, sterilization methods and growth conditions.
3. Gain knowledge on various micro propagation methods – meristem culture, direct and indirect organogenesis and embryogenesis, soma clonal variation, haploid culture, embryo culture and protoplast culture and hardening procedures for tissue culture plantlets.

Course Outcomes:
The students will be able to:

1. Demonstrate the concepts and principles of plant tissue culture.
2. Apply the methods of explant sterilization and inoculation procedures.
3. Prepare different media used in tissue culture and its application for different crops.
4. Expertise on various micropropagation methods such as meristem culture, enhanced release of axillary buds, direct and indirect organogenesis, embryogenesis, anther and embryo culture.
5. Identify the soma clonal variants and problems arising due to soma clonal variations.
6. Familiarize with the conditions and structures used in hardening of plantlets.

23HO2278 HI-TECH HORTICULTURE
Credits: 2:0:1 (2+1)
Course Objectives:
Enable the students to:

1. Gain knowledge on precision farming of horticultural crops
2. Familiarize with various protected structures and green house management practices
3. Acquire skills in high density orcharding, canopy management and fertigation systems

Course Outcomes:
The students will be able to:

1. Demonstrate design and laying out of high-density orchards
2. Apply knowledge of production techniques for canopy management in high density orchards.
3. Apply the knowledge gained in remote sensing, GIS, GPS, and VRA to practice precision farming
4. Design and establish different protected structures and operate climate control systems.
5. Design and execute micro irrigation systems and fertigation under open and protected conditions.
6. Develop entrepreneurial skills in precision farming and protected cultivation.

4) List of new Elective Courses for B.Sc. (Hons) Agriculture

S. No.	Discipline	Course Code	Name of the Course	Credits
1.	AEC	23MS2001	Concepts and Applications in Entrepreneurship	3(3+0)
2.	AGR	24AG2014	RS, GIS & GPS in Precision Farming	3(2+1)
3.	SAC	24AG2310	Climate- Smart Agriculture	3(2+1)
4.	AEG	24AG2455	Drones and their Applications in Agriculture.	3(2+1)
5.	AEC	24AG2553	Basics of Artificial Intelligence in Agriculture	3(3+0)

24AG2014 RS, GIS & GPS IN PRECISION FARMING

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the student to:

1. Learn the principles of precision farming and its applications.
2. Gain knowledge on basic principles of GIS, RS and GPS.
3. Analyse and interpret data generated through precision farming practices.

Course outcomes:

The student will be able to:

1. Define the concepts of Precision Agriculture and spatial tools to optimize farming practices.
2. Apply Global Positioning System (GPS) to enhance precision in agricultural activities.
3. Utilize Geographical Information Systems (GIS) for decision-making in precision farming and site-specific crop production.
4. Comprehend the role of database management systems in Agriculture.
5. Apply Remote sensing data in precision farming.
6. Identify soil and crop management factors and predict crop productivity.

Theory

Importance of Precision Agriculture and mapping in farming for decision making, Benefits of Precision Agriculture, Geographical concepts of PA, Geographical Positioning System, Introduction to GIS, IDI devices usage in Precision Agriculture, Remote sensing Data collection, Data analysis, Analysis application, Goals based on end results of Precision Agriculture, Economic of precision agriculture & determining equipment and software

Importance of Precision Agriculture and geographical mapping in farming, Benefits of Precision Agriculture, Introduction to GPS and GIS, Application of GPS and GIS in PA, IDI devices usage in Precision Agriculture, Remote sensing Data for agriculture, Data analysis, IoT for Precision Agriculture. Decision support system for Land management, Assessing NDVI Spatial pattern as related to irrigation and soil salinity management.

Practicals

Determining Latitude/Longitude, UTM (Universal Transverse Mercator) or State Plane Position, Navigation with waypoints, configuring a GPS system, Building a “Mapped Database”, Building an Agricultural Database, Comparing aerial photos to topographic maps, Grid sampling process, yield map, thematic or spatial resolution, ArcGIS, Examples of Decision making, Development of a business plan for integration of Precision Agriculture technology.

Georeferencing of Images and Maps, Mapping from agricultural database, Understanding spatial resolution, Extraction of data based on Queries, Estimation of agricultural yield, Examples of Decision making projects, Development of a business plan for integration of Precision Agriculture technology.

References:

1. Adam, N.R. and Gangopadhyay, A., 2000, Database Issues in Geographic Information Systems, Kluwer Academic Publishers, Massachusetts (USA), pp. 43-44.
2. Bhatta B., 2008, Remote Sensing and GIS, Oxford University press, New Delhi, pp. 8-9, 18-36
3. Burrough, P.A. (1986). Principles of GIS for Land Resource Assessment
4. Chrisman Nicholas. (1987). Exploring Geographic Information Systems. John Wiley
5. Ghosh P, P. Kumpatla S. GIS Applications in Agriculture [Internet]. Geographic Information Systems and Applications in Coastal Studies. Intech Open; 2022. Available from: <http://dx.doi.org/10.5772/intechopen.104786>
6. Heywood, Ian., Cornelius Sarah and Carver Steve. (1989). An Introduction to Geographic Information Systems. Addison-Wesley- Longman
7. Lamine, S., Srivastava, P.K., Kayad, A., Munõz-Arriola, F. and Pandey, P.C., 2023. Remote sensing in precision agriculture: transforming scientific advancement into innovation, 1st Edition
8. Lanya¹, N Subadiyasa¹, K Sardiana¹ and G P Ratna Adi. 2019. *IOP Conf. Ser.: Earth Environ. Sci.* **313** 012046.
9. Liu, J.,G. and Mason, P., J., 2009, Essential Image Processing and GIS for Remote Sensing, John Wiley & Sons Ltd., pp. 157-161.
10. Roy, Lagnajeet, Ganchaudhuri, Somnath, Pathak, Karabi, Dutta, Khanikar andPunya. 2022. Application of Remote sensing and GIS in agriculture. 9. 460-482. 10.1729/Journal.29398.

11. Sabins, J.R. (1987). Remote Sensing Principles and Interpretations, W.H. Freeman & Co.Sons.

24AG2310 CLIMATE- SMART AGRICULTURE

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Demonstrate plant anatomy and health monitoring using cutting edge technologies.
2. Apply Sensors and actuators for farming practices, sensor data acquisition and telemetry.
3. Acquire knowledge about advanced technologies for smart farming.

Course Outcomes:

The students will be able to:

1. Monitor the plant health using cutting edge technologies.
2. Assess the soil fertility using sensors.
3. Demonstrate drone technology for fertilizing and crop mapping.
4. Utilize sensors for climate and weather monitoring.
5. Apply telemetry for IOT.
6. Make use of android-based automation for smart farming.

Theory

Plant health monitoring: Measurement of leaf health, chlorophyll detection, ripeness level, crop mapping, fertilizing, Drone technology for soil field analysis and assistive operations, Leaf Area Index mapping.

Sensors: Classification and characteristics, Smart sensors, Colorimetry based detection, MEMS Electrochemical Sensors, Dielectric Soil Moisture Sensors, ISFET, Weather sensors, Proximity Sensors, Signal conditioning and converters

Telemetry: Wireless communication modules and topology, Zig-bee, Bluetooth, LORA, Zero power devices, Energy Harvesting technology

Technologies for farming: Water quality monitoring, nutrient mapping, weather forecasting, micro-irrigation system, solar pump and lighting system, Fencing, Android based automation for agriculture.

Practicals

Plant health monitoring through sensors: Understanding the working procedure of Smart sensors and their utility in agriculture (Acoustic based sensors, electromagnetic sensors, optical sensors, electrochemical sensors, Field programmable gate array-based sensors, Flexible and wearable sensors, Battery -free self powered sensors), Practical applications of telemetry in farming, Application of automation in agriculture- Wi- Fi, Bluetooth, Zig Bee, Ethernet.

References:

1. Leslie Lipper, Nancy McCarthy, David Zilberman, Solomon Asfaw, Giacomo Branca, Climate Smart Agriculture-Building Resilience to Climate Change. In: Natural Resource Management and Policy (NRMP, volume 52). 2018. Springer.
2. Ouda, Samiha, and Abd El-Hafeez Zohry. *Climate-Smart Agriculture : Reducing Food Insecurity*. Cham, Switzerland: Springer International Publishing, 2022. Print.
3. Fahad, Shah, ed. *Plant Growth Regulators for Climate-Smart Agriculture*. Boca Raton, Florida ; CRC Press, 2021. Print.
4. Bhattacharyya, P., Pathak, H., Pal, S Climate Smart Agriculture: Concepts, Challenges, and Opportunities.2020. Germany: Springer Nature Singapore.

24AG2455 DRONES AND THEIR APPLICATIONS IN AGRICULTURE

Credits: 2:0:1 (2+1)

Course Objectives:

Enable the students to:

1. Understand the fundamentals of drone technology.
2. Gain knowledge on the application of drones in crop health monitoring.
3. Get insight in advanced application and future trends of drone for agriculture.

Course Outcomes:

The students will be able to:

1. Comprehend the different types of drones and their applications in agriculture.
2. Relate the design parameters of drone systems.

3. Obtain knowledge on payloads for drone.
4. Develop skills in operating and managing agricultural drones effectively for mapping.
5. Analyse drone-collected data to inform crop management decisions.
6. Explore the potential of advanced drone applications and future trends in agriculture.

Theory

Fundamentals of Drones: History and evolution of agricultural drones, different types of drones (Fixed-wing, Multirotor, VTOL), elements of an agricultural drone, regulations and safety considerations for drone operation in agriculture.

Design of Drone Systems: Aerodynamics and airframe configurations – aspects of airframe design - unmanned aircraft characteristics, payloads, battery life, flight time estimation, thrust to weight calculation.

Drone Payloads: Sensors and payloads – payload types – Communications, Control and stability, Navigation – Launch and recovery.

Crop monitoring and field mapping: Multiband drones, NDVI, NDRE, RGB, DSM, vegetation index, types, determination of crop health, multispectral and hyperspectral cameras used in drones for crop health monitoring, data acquisition techniques and flight planning, processing and analysis of drone-collected data.

Drone-Based Applications in Crop Management: Seeding and fertilization using drones, weed control and herbicide spraying, precision irrigation and water management, crop scouting and pest control.

Advanced Applications and Future Trends: Livestock monitoring and herd management, automated spraying and precision agriculture services, integrating drones with other agricultural technologies (AI, IoT), exploring the potential of drone-based pollination and frost protection.

Practicals

1. Components of the drones in Agriculture, practically learning the operation procedure using the safety measures
2. Utilizing the sensors and payloads attached to the drones based on thrust weight calculation.
3. Collection of data regarding crop health and processing and analysis of data
4. Demonstration of seeding, fertilizer application, weedicide, herbicide spraying using drones
5. Practical demonstration of drones in precision agriculture and protected farming.
6. Integrating Drones with AI and IOT in precision agriculture

Text Books

1. Paul. G. Fahlstrom, Thomas. J. Gleason Introduction to UAV systems, UAV SYSTEMS, Ins. 2013.
2. K. R. Krishna, Agricultural Drones A Peaceful Pursuit, Apple Academic Press, 2018
3. Aboul Ella Hassanien, Anand Nayyar, Rajalakshmi Krishnamurthi, Development and Future of Internet of Drones (IoD): Insights, Trends and Road Ahead, Springer International Publishing, 2021.

Reference Books

1. Pethuru Raj, Kavita Saini, Vinicius Pacheco, Applying Drone Technologies and Robotics for Agricultural Sustainability, DOI: 10.4018/978-1-6684-6413-7, January, 2023.
2. Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft systems", CRC press, Taylor and Francis, New York, 2012.

24AG2553 BASICS OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

Credits: 3:0:0 (3+0)

Course Objectives:

1. Use the correct vocabulary to characterize neural networks, modern AI and the history of AI development.
2. Identify important applications of phenotype prediction, soil and water quality assessment, weather forecasting and crop and livestock monitoring in agriculture.
3. Understand and identify the suitable machine learning tool for the problems in agriculture.

Course Outcomes:

The students will be able to:

1. Comprehend the basics of AI, ML and DA.
2. Utilize the various tools and libraries for artificial intelligence.
3. utilize the suitable machine learning algorithms such as regression and classification for problem solving.
4. Utilize AI and ML to improve efficiency in irrigation, soil quality sensing, crop- monitoring, weeding, crop establishment.
5. Demonstrate to farmers the AI- based technological produce more output with less input.

- Evaluate the process of AI transforming agriculture, an emerging trend that will help spur an agricultural revolution.

Theory:

Artificial Intelligence – introduction, history, types, need and scope in agriculture, application of AI in agriculture. Tools and libraries for artificial intelligence. Machine learning and deep learning algorithms: Regression – Simple linear regression, multiple linear regression, Ridge and LASSO regression. Classification: Decision tree, Random forest. Deep learning algorithms: Neural network, support vectors, CNN, etc. Problem solving using AI in agriculture: Crop-Related Applications - Nutrient Deficiency Detection, Plant Species Recognition, Crop Disease Identification, Soil Quality Analysis, Predictive Analytics for Crop Yield, AI in Precision Farming, Weather Related Applications- Weather Prediction Model, Weather based pest prediction, Heat stress mitigation, Water-Related Applications: Water Quality Assessment, Irrigation Optimisation, Drought Impact Prediction., Live Stock-Related Applications: Automated Livestock Counting, Fish Farming Monitoring, Automated Cattle Monitoring and Health Assessment.

Reference:

- Rajesh Singh, Anita Gehlot, Mahesh Kumar Prajapat and Bhupendra Singh, 2021. Artificial Intelligence in Agriculture, CRC Press.
- U. Kose, V. Prasath, M. Mondal, P. Podder and S. Bharati, 2022. Artificial Intelligence and Smart Agriculture Technology.
- Ethem Mining, 2020. Machine Learning for Beginners. A Complete and Phased Beginner's Guide to Learning and Understanding Machine Learning and Artificial Intelligence.

LIST OF COURSES WITH UPDATED COURSE OBJECTIVES AND COURSE OUTCOMES

S. No	Discipline	Course Code	Name of the Course	Credits
1	AGR	21AG3015	Current Trends in Agronomy	3(3+0)
2	AGR	21AG3016	Crop Ecology	2(2+0)
3	AGR	21AG3017	Irrigation Management	3(2+1)
4	AGR	21AG3018	Advances in Weed management	2(2+0)
5	AGR	21AG3019	Integrated Farming Systems for Sustainable Agriculture	2(2+0)
6	AGR	21AG3020	Soil Conservation and Watershed Management	3(2+1)
7	AGR	21AG3021	Stress Crop Production	3(2+1)
8	GPB	21AG3038	Plant Genetic Resources and Their Utilization	2(2+0)
9	GPB	21AG3039	Advances in Quantitative Genetics	3(2+1)
10	GPB	21AG3040	Genomics in Crop Improvement	3(2+1)
11	GPB	21AG3041	Cellular and Chromosomal Manipulations in Crop Improvement	2(2+0)
12	GPB	21AG3042	Advanced Plant Breeding Systems	2(2+0)
13	GPB	21AG3043	Crop Evolution	2(2+0)
14	GPB	21AG3044	Breeding Designer Crops	3(2+1)
15	GPB	21AG3045	Advances in Breeding of Major Field Crops	3(3+0)
16	AEN	21AG3090	Advanced Insect Systematics	3(1+2)
17	AEN	21AG3091	Advanced Insect Physiology	2(2+0)
18	AEN	21AG3092	Advanced Insecticide Toxicology	3(2+1)
19	AEN	21AG3093	Molecular Approaches in Entomological Research	2(1+1)
20	AEN	21AG3094	Advanced Integrated Pest Management	2(2+0)
21	AEN	21AG3095	Insect Behaviour	2(1+1)
22	AEN	21AG3096	Recent Trends in Biological Control	2(1+1)
23	AEN	21AG3097	Advanced Host Plant Resistance	2(1+1)
24	AEN	21AG3098	Advanced Acarology	2(1+1)
25	PAT	21AG3117	Advanced Mycology	3(2+1)
26	PAT	21AG3118	Advanced Virology	3(2+1)
27	PAT	21AG3119	Advanced Bacteriology	3(2+1)

28	PAT	21AG3120	Molecular Basis of Host Pathogen Interaction	3(2+1)
29	PAT	21AG3121	Principles and Procedures of Certification	1(1+0)
30	PAT	21AG3122	Plant Biosecurity and Biosafety	2(2+0)
31	PAT	21AG3123	Advances in Nematode Management	3(2+1)
32	FSC	21HO3127	Growth and Development of Horticultural Crops	3(2+1)
33	FSC	21HO3136	Advances in Production of Fruit crops	3(2+1)
34	FSC	21HO3137	Advances in Growth Regulation of fruit crops	3(2+1)
35	FSC	21HO3138	Advances in Breeding of Fruit crops	3(2+1)
36	FSC	21HO3139	Genomics and Bioinformatics in Horticulture	3(2+1)
37	FSC	21HO3140	Biotic and Abiotic Stress management in Horticultural crops	3(2+1)
38	FSC	21HO3141	Environmental Horticulture	3(2+1)
39	VEG	21HO3154	Advances in Vegetable Production	3(2+1)
40	VEG	21HO3155	Advances in Breeding of Vegetable Crops	3(2+1)
41	VEG	21HO3156	Protected Cultivation of Vegetable Crops	2(1+1)
42	VEG	21HO3157	Biotechnology in Vegetable Crops	3(2+1)
43	VEG	21HO3158	Seed Certification, Processing and Storage of Vegetable crops	2(1+1)
44	FLA	21HO3171	Advances in Flower Production Technology	3(2+1)
45	FLA	21HO3172	Advances in Protected and Precision Floriculture	2(1+1)
46	FLA	21HO3173	Advances in Breeding of Flower Crops	3(2+1)
47	FLA	21HO3174	Advances in Landscape Architecture	3(1+2)
48	FLA	21HO3175	Advances in Biochemistry and Biotechnology of Flowers	3(2+1)
49	PSM	21HO3188	Advances in Production of Plantation Crops	3(2+1)
50	PSM	21HO3189	Advances in Spice Production	3(2+1)
51	PSM	21HO3190	Advances in Medicinal and Aromatic Crop Production Technology	3(2+1)
52	PSM	21HO3191	Advances in Breeding of Plantation Crops and Spices	3(2+1)
53	PSM	21HO3192	Advances in Breeding of Medicinal and Aromatic crops	3(2+1)
54	PHT	21HO3206	Physiology of Ripening and Senescence	2(1+1)
55	PHT	21HO3207	Novel Processing Technologies for Horticultural Produce	3(2+1)
56	PHT	21HO3208	Advances in Laboratory Techniques in Post-Harvest Technology	3(1+2)
57	PHT	21HO3209	Advances in Packaging Technology of Horticultural Produce	2(1+1)
58	PHT	21HO3210	Storage Techniques and Supply/Cold Chain Management of Horticultural Produce	3(2+1)
59	Common Course	21AG3222	Library and Information Services	1(0+1)
60	Common Course	21AG3223	Technical writing and Communications Skills	1(0+1)
61	Common Course	21AG3224	Intellectual Property and its management in Agriculture	1(1+0)
62	Common Course	21AG3225	Basic concepts in Laboratory Techniques	1(0+1)
63	Common Course	21AG3226	Agricultural Research, Research Ethics and Rural Development Programs	1(1+0)
64	BTH	21AG3227#	Introduction to Bioinformatics	3(2+1)
66	PAT	21AG3232#	Current Topics in Nematode Disease Development and Host Resistance	3(2+1)
67	AEC	21AG3233#	Advanced Design of Experiments	2(2+0)

68	AEC	21AG3235#	Mathematical Modelling in Agricultural Sciences	2(1+1)
69	AGR	21AG3236#	Weather Forecasting Methods and Yield Prediction	3(2+1)
70	AGR	21AG3240	Advances in Agro-Meteorology	3(3+0)
71	AGR	21AG3241	Advances in Weed Management	3(3+0)
72	AGR	21AG3242	Crop Water Requirements and Irrigation Scheduling	3(3+0)
73	AGR	21AG3243	Advances in Cropping and Farming Systems	2(2+0)
74	AGR	21AG3244	Advances in Crop Production and System Modelling	2(2+0)
75	AGR	21AG3245	Advances in Soil Fertility and Crop Management	2(2+0)
76	GPB	21AG3246	Genomics Assisted Breeding in Crops	3(3+0)
77	GPB	21AG3247	Cytogenetics and Chromosome Manipulation in Crops	3(3+0)
78	GPB	21AG3248	Advanced Plant Breeding Systems	3(3+0)
79	GPB	21AG3249	Biometrical Techniques in Crop Improvement	2(2+0)
80	GPB	21AG3250	Plant Genetic Resources and Its Importance	2(2+0)
81	GPB	21AG3251	Breeding For Stress and Quality Traits	2(2+0)
82	AEN	21AG3252	Advanced Insect Taxonomy	3(3+0)
83	AEN	21AG3253	Insect Toxicology	3(3+0)
84	AEN	21AG3254	Host Plant Resistance	3(3+0)
85	AEN	21AG3255	Biotechnological Approaches in Entomological Research	2(2+0)
86	AEN	21AG3256	Integrated Insect Pest Management	2(2+0)
87	AEN	21AG3257	Biological Control of Insect Pests	2(2+0)
88	PAT	21AG3258	Advanced Mycology	3(3+0)
89	PAT	21AG3259	Advanced Virology	3(3+0)
90	PAT	21AG3260	Advanced Bacteriology	3(3+0)
91	PAT	21AG3261	Molecular Basis of Host-Pathogen Interaction	2(2+0)
92	PAT	21AG3262	Plant Biosecurity and Biosafety	2(2+0)
94	PAT	21AG3263	Principles and Procedures of Certification	2(2+0)
95	FSC	21HO3270	Production Technology Trends in Fruit Crops	3(3+0)
96	FSC	21HO3271	Advances in Growth Physiology of Fruit Crops	3(3+0)
97	FSC	21HO3272	Fruit Crop Improvement	3(3+0)
98	HOR	21HO3273	Genetic Resource Informatics in Horticulture	2(2+0)
99	HOR	21HO3274	Stress Management in Horticultural Crops	2(2+0)
100	HOR	21HO3275	Environmental Science in Relation to Horticulture	2(2+0)
101	FLR	21HO3276	Recent Trends in Flower Cultivation Practices	3(3+0)
102	FLR	21HO3277	Recent Trends in Breeding of Flower Crops	3(3+0)
103	FLR	21HO3278	Advances in Landscape Architecture	3(3+0)
104	FLR	21HO3279	Recent Trends in Protected and Precision Floriculture	2(2+0)
105	FLR	21HO3280	Recent Trends in Biochemistry and Biotechnology of Flowers	2(2+0)
106	HOR	21HO3281	Control of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)
107	VEG	21HO3282	Recent Trends in Vegetable Production	3(3+0)
108	VEG	21HO3283	Recent Trends in Breeding of Vegetable Crops	3(3+0)
109	VEG	21HO3284	Protected Cultivation of Vegetable Crops	3(3+0)
110	VEG	21HO3285	Biotechnology in Vegetable Crops	2(2+0)
111	VEG	21HO3286	Seed Certification, Processing and Storage of Vegetable Crops	2(2+0)

112	HOR	21HO3287	Control of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)
113	PTS	21HO3288	Advances in Production Technology of Plantation Crops	3(3+0)
114	PTS	21HO3289	Advances in Production Technology of Spice Crops	3(3+0)
115	PTS	21HO3290	Advances in Production Technology of Medicinal and Aromatic Crops	3(3+0)
116	PTS	21HO3291	Advances in Breeding Methods of Plantation and Spice Crops	2(2+0)
117	PTS	21HO3292	Advances in Breeding Methods of Medicinal and Aromatic Crops	2(2+0)
118	HOR	21HO3293	Advances in Biotic and Abiotic Stress Management in Horticultural Crops	2(2+0)
119	PHT	21HO3294	Novel Processing Technologies for Horticultural Produce	3(3+0)
120	PHT	21HO3295	Advances in Laboratory Techniques in Post-Harvest Technology	3(3+0)
121	PHT	21HO3296	Management of Storage and Supply/Cold Chain Techniques of Horticultural Produce	3(3+0)
122	PHT	21HO3297	Advances in the Physiology of Ripening and Senescence	2(2+0)
123	PHT	21HO3298	Management of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)
124	PHT	21HO3299	Innovative Packaging Technology for Horticultural Produce	2(2+0)

21AG3016 CROP ECOLOGY

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Review different agricultural systems.
2. Comprehend different types of agro-ecological regions in crop production.
3. Relate the adaptation of crops in different agro-climatic conditions.

Course Outcomes:

The students will be able to:

1. Gain insights on the characteristics of crop ecosystem.
2. Identify the roles of ecological factors in crop production.
3. Understand the composition and functions of the ecosystem.
4. Identify the major ecological.
5. Develop sustainable management practices for sound farming ecosystem.
6. Recommend measures for mitigating the environmental resistance to enhance crop production.

21AG3018 ADVANCES IN WEED MANAGEMENT

Credits: 2 (2+0)

Course Objectives:

Enable the students to:

1. Relate the weeds in different ecosystems and their impact on modern crop production.
2. Comprehend herbicides and their application in integrated weed management.
3. Review the advanced methods of weed management techniques in modern crop production.

Course Outcomes:

The students will be able to:

1. Identify the different types of weeds and their ecosystem.
2. Understand the weed biology.
3. Apply the knowledge about herbicides and their effects on modern crop production.
4. Compute the compatibility of different herbicide groups and with different agrochemicals.

5. Recommend the advanced biotechnological tools and concepts in weed management
6. Evaluate various bioassay and other herbicide residue assessment techniques.

21AG3038 PLANT GENETIC RESOURCES AND THEIR UTILIZATION

Credits: 2(2+0)

Course objectives:

Enable the students to:

1. Understand the concepts of plant exploration, collection and conservation
2. Familiarize the Intellectual Property Rights
3. Gain knowledge on crop germplasm and genetic enhancement

Course Outcomes:

The students will be able to:

1. Identify micro and mega gene centres and diversity hotspots and their importance
2. Acquire skills for germplasm collection, conservation and maintenance
3. Evaluate the procedures in germplasm exchange
4. Analyze the intellectual property rights and their regulations
5. Utilize germplasm resources for crop improvement
6. Analyze the wide hybridization barriers and breeding techniques to overcome them

21AG3039 ADVANCES IN QUANTITATIVE GENETICS

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Understand the theoretical and computation skills for estimating the components of variation
2. Explore the mating designs in plant breeding
3. Interpret the gene action, scales and gene effects

Course Outcomes:

The students will be able to:

1. Rely on suitable breeding procedures for trait specific improvement
2. Apply their knowledge on gene actions and selection indices for identifying suitable parents
3. Analyze the designs of experiments involved in breeding programs
4. Interpret the results effected in mating designs and analyze their statistical parameters
5. Generate mapping populations for QTL analysis and marker assisted selection
6. Detect the marker-trait association in a population and use it for population improvement

21AG3040 GENOMICS IN CROP IMPROVEMENT

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge in advanced molecular techniques in genome mapping
2. Understand Structural and functional genomics
3. Realize Development of transgenic crops

Course Outcomes:

The students will be able to:

1. Evaluate the molecular description of nuclear and organellar genomes
2. Analyze the mechanism of genetic control over gene expression and regulation
3. Apply the knowledge in gene and QTL mapping
4. Incorporate the knowledge in sequencing techniques
5. Conceptualize the strategies for TILLING and ECO-TILLING
6. Examine the role of 'omics' in linking of the genome with phenome

21AG3041 CELLULAR AND CHROMOSOMAL MANIPULATIONS IN CROP IMPROVEMENT

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the structure and organization of genomes.

2. Apply cytogenetic techniques for genetic analysis, gene mapping, and introgression tracking.
3. Utilize cytogenetics to locate genes, evaluate polyploidy's impact in crop breeding.

Course Outcomes:**The students will be able to:**

1. Define genome structure, including repetitive sequences, and its organization in nuclear and organellar genomes.
2. Apply cytogenetic techniques for chromosome analysis, genetic mapping, and introgression tracking.
3. Utilize cytogenetics to locate genes, assess polyploidy's impact on crops, and improve crop traits.
4. Determine the behaviour of interspecific and intergeneric crosses in hybridization strategies for crop improvement.
5. Analyse different in vitro morphogenesis techniques for crop improvement.
6. Assess tissue culture techniques and their potential applications in biotic and abiotic stress tolerance.

21AG3042 ADVANCED PLANT BREEDING SYSTEMS**Credits: 2(2+0)****Course Objectives:****Enable the students to:**

1. Understand the computational methods for non-allelic interactions
2. Gain knowledge on Mating designs in Crop Improvement Programs
3. Review the Component analysis and their significance in plant breeding

Course Outcomes:**The students will be able to:**

1. Analyse the evolutionary concepts of plant breeding
2. Apply the principles of plant breeding in developing breeding populations
3. Develop Mendelian and complex populations for identifying desirable lines
4. Evaluate the selection principles for self- and cross-pollinated crops
5. Analyze different genetic engineering methods for developing male sterile populations
6. Generate new cyto-nuclear systems to diversify the male sterile systems

21AG3043 CROP EVOLUTION**Credits: 2(2+0)****Course Objectives:****Enable the students to:**

1. Acquire knowledge on Concepts of crop evolution
2. Conceptualize the Domestication of different crops from centers of origin
3. Ploidy level manipulations for crop improvement

Course Outcomes:**The students will be able to:**

1. Gain expertise on evolution of various crop species
2. Comprehend the process of speciation and domestication
3. Analyze the methods for exploiting the natural variation
4. Apply the knowledge on concepts of crop evolution for Crop Improvement
5. Realize the historical domestication events
6. Conserve the genetic base of a crop

21AG3044 BREEDING DESIGNER CROPS**Credits: 3(2+1)****Course Objectives:****Enable the students to:**

1. Explain the principles of physiological efficiency in crops.
2. Evaluate the effectiveness of biofortification methods for enhancing crop nutrition.
3. Design breeding strategies for specialized traits in crops for industrial and pharmaceutical use.

Course Outcomes:**The students will be able to:**

1. Apply physiological principles to improve crop traits.

2. Analyze and compare various biofortification techniques to enhance crop nutritional content.
3. Develop and propose effective breeding strategies to create crops with unique traits for specific applications.
4. Demonstrate advanced hybridization techniques in crop breeding.
5. Create and evaluate designer crops with enhanced industrial and pharmaceutical applications.
6. Evaluate and recommend biosafety protocols and post-harvest management practices for designer crop production.

21AG3045 ADVANCES IN BREEDING OF MAJOR FIELD CROPS

Credits: 3 (3+0)

Course Objectives:

Enable the students to:

1. Gain insight on recent advances in improvement of cereals, millets and non-cereal crops
2. Understand the principles of conventional breeding approaches in field crop improvement
3. Realize the use of modern biotechnological tools in the improvement of major field crops

Course Outcomes:

The students will be able to:

1. Do research on speciation and phylogenetic relationship in field crops
2. Outline the objectives, concepts, breeding methods of field crops
3. Develop breeding strategies for major field crops
4. Apply their knowledge of advanced hybridization techniques and inbreeding methods to develop new crop varieties
5. Apply methods of breeding in development of biotic and abiotic stress resistant varieties
6. Appreciate the achievements in genetic improvement of field crops

21AG3090 ADVANCED INSECT SYSTEMATICS

Credits: 3(1+2)

Course Objectives:

Enable the students to:

1. Understand the insect classification, phylogenetics, classical and molecular methods
2. Gain knowledge on different groups of insects and International Code of Zoological Nomenclature
3. Acquire knowledge on ethics and procedure for taxonomic publications

Course Outcomes:

The students will be able to:

1. Understand about insect classification, evolutionary history and cladistics.
2. Relate with the International Code of Zoological Nomenclature, including appendices to ICZN-Ethics.
3. Comprehend the knowledge on the evolution of insects.
4. Apply the concept of phylocode.
5. Analyze the alternative naming systems for insects
6. Acquire skills on molecular taxonomy and barcoding species

21AG3091 ADVANCED INSECT PHYSIOLOGY

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the physiology of various systems includes digestion, reproductive and nervous system
2. Gain knowledge on physiology and biochemistry of insect cuticle and moulting process
3. Acquire knowledge on physiology of insect growth and development

Course Outcomes:

The students will be able to:

1. Understand the physiology and biochemistry of insect exoskeleton.
2. Acquire knowledge on the mechanism of chitin biosynthesis, chitin-protein interactions in body wall.
3. Understand the physiology of digestive enzymes in phytophagous, wood boring and wool feeding insects.

4. Examine the detailed physiology of nervous, excretion, reproductive, respiratory and circulatory mechanisms.
5. Examine endocrine system and muscle contractions.
6. Analyze the functions of pheromones and semio chemicals in insect growth and development.

21AG3092 ADVANCED INSECTICIDE TOXICOLOGY

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Understand the latest advancements in the field of insecticide toxicology.
2. Gain knowledge on biochemical and physiological target sites of insecticides.
3. Acquire knowledge on Pesticide resistance mechanisms in insects.

Course Outcomes:

The students will be able to:

1. Understand the penetration and distribution of insecticides in insect systems.
2. Evaluate the problems associated with pesticide residues in agriculture ecosystem.
3. Analyze the biochemical and physiological target sites of insecticides in insects.
4. Apply insecticide laws and standards, and good agricultural practices.
5. Acquire skills on biochemical and biological techniques for detection of insecticide resistance in insects.
6. Correlate different methods for estimation of insecticide residues.

21AG3093 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Acquire knowledge on molecular techniques in entomological research
2. Gain Knowledge on biotechnological approaches in sericulture and apiculture
3. Understand genes of interest in entomological research

Course Outcomes:

The students will be able to:

1. Understand the techniques used in molecular biology.
2. Apply DNA and RNA analysis for insect identification.
3. Identify and classify genes for characters of interest.
4. Examine the genetic improvement of natural enemies
5. Acquire skills on insect gene transformation in relation to silkworms and honey bees
6. Apply resistance management strategy in transgenic crops

21AG3094 ADVANCED INTEGRATED PEST MANAGEMENT

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand recent problems with alien pest and use of IPM.
2. Acquire knowledge on surveillance and data base management as a tool in IPM.
3. Gain knowledge on successful national and international case histories of integrated pest management.

Course Outcomes:

The students will be able to:

1. Understand the principles and concepts of IPM.
2. Acquire skills on data base management, simulation techniques and system analysis.
3. Apply new technologies in genetic engineering and their progress in IPM Programs.
4. Analyze the different strategies in pesticide resistance management.
5. Correlate with new technologies and their progress in IPM.
6. Evaluate the scope and limitations of bio-intensive and ecological based IPM Programs.

21AG3095 INSECT BEHAVIOUR

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Understand the behavioural responses in natural selection.
2. Acquire knowledge on adaptability and various survival strategies in insects.
3. Gain knowledge on manipulating the insect behaviour for pest management.

Course Outcomes:

The students will be able to:

1. Correlate the behaviour and behavioural polymorphism in natural selection and genetic control.
2. Evaluate the concept of insect communication and orientation.
3. Examine the reproductive and social behaviour in insects.
4. Analyze the tritrophic interaction.
5. Apply insect behaviour in communication and defense as a tool for host selection.
6. Analyze the behavioural manipulation as potential tool in pest management.

21AG3096 RECENT TRENDS IN BIOLOGICAL CONTROL

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Understand the role of biocontrol agents in pest management.
2. Acquire knowledge on advanced techniques for mass multiplication and field release of biocontrol agents.
3. Gain knowledge on scope of biocontrol agents in organic farming system.

Course Outcomes:

The students will be able to:

1. Understand the scope of classical biological control and augmentative biocontrol.
2. Identify and classify the biocontrol agents against target pest populations.
3. Acquire skills on mass culturing techniques of biocontrol agents.
4. Evaluate the scope of genetically engineered microbes and parasitoids in biological control.
5. Analyze the various methods of application of biocontrol agents.
6. Apply the knowledge for overcoming insecticide resistance pest population using biocontrol agents.

21AG3097 ADVANCED HOST PLANT RESISTANCE

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Understand the recent advances in resistance of plants to insects.
2. Acquire knowledge on techniques for assessment and evaluation of resistance in crop plants.
3. Gain knowledge on biotechnological approaches in host plant resistance.

Course Outcomes:

The students will be able to:

1. Acquire skills on techniques and determination of categories of plant resistance.
2. Understand the importance of plant resistance.
3. Analyze the physical and chemical environment factors conferring resistance in plants.
4. Evaluate the mechanisms of resistance for orientation, feeding, oviposition etc.,
5. Identify the plant resistance based on genotype expression.
6. Apply the advanced biotechnological tools in host plant resistance.

21AG3098 ADVANCED ACAROLOGY

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Understand economically important groups of Acari causing damage to crop plants.
2. Acquire knowledge on economical important species of mites in agriculture.
3. Gain knowledge on phytophagous mites using acaricides and predatory mites.

Course Outcomes:**The students will be able to:**

1. Understand the morphology and phylogeny of mites of economic importance.
2. Apply the knowledge on ecology and population dynamics of mites.
3. Identify the taxonomic characteristics of mite species.
4. Analyze the biotic and abiotic factors influencing the population of mites.
5. Acquire skills on mass production and utilization of predatory mites.
6. Correlate the mite species related to veterinary, public health and storage acarology.

21AG3117 ADVANCED MYCOLOGY**Credits: 3(2+1)****Course Objectives:****Enable the students to:**

1. Understand the advances in molecular taxonomy of fungi
2. Acquire knowledge on Morphology and reproduction of fungi
3. Gain knowledge on pathogenic variability and heterokaryosis of fungi

Course Outcomes:**The students will be able to:**

1. Review the recent taxonomy of fungi.
2. Comprehend morphological and sexual characters of fungi
3. Analyze the population biology of fungi
4. Evaluate the variability of fungal pathogens
5. Conceptualize nuclear inheritance among fungal pathogens
6. Acquire skills on role of fungus in biodegradation

21AG3118 ADVANCED VIROLOGY**Credits: 3(2+1)****Course Objectives:****Enable the students to:**

1. Understand the mechanism of virus infection.
2. Gain knowledge on antibody production technology.
3. Acquire knowledge about genome organization, replication, transcription and translational strategies,

Course Outcomes:**The students will be able to:**

1. Comprehend the virus infection and replication.
2. Analyse the virus-vector relationship.
3. Apply the knowledge on development of immunodiagnostic kits.
4. Conceptualize various molecular tools for identification of pathogenic viruses.
5. Review the genomic organization of various plant viruses.
6. Acquire skills on genetic engineering with plant viruses, viral suppressors, an RNAi dynamic, resistant genes.

21AG3119 ADVANCED BACTERIOLOGY**Credits: 3 (2+1)****Course Objectives:****Enable the students to:**

1. Gain knowledge on the latest taxonomy of phytopathogenic bacteria.
2. Understand the secretion systems of bacteria.
3. Review Host defense mechanism and genetic engineering

Course Outcomes:**The students will be able to:**

1. Analyse the Host-bacterial pathogen interaction.
2. Correlate the factors responsible for disease spread.
3. Administer knowledge on molecular characterization of phytopathogenic bacteria
4. Conceptualize host defense mechanism.

5. Acquire skills of Genetic engineering for management of bacterial plant pathogens.
6. Evaluate the beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management.

21AG3120 MOLECULAR BASIS OF HOST PATHOGEN INTERACTION

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Understand the advanced techniques in Molecular Plant Pathology.
2. Gain knowledge on the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.
3. Acquire knowledge on genetic engineering approach for management of plant disease.

Course Outcomes:

The students will be able to:

1. Conceptualize the mechanism of host-pathogen interactions.
2. Comprehend induced systemic resistance.
3. Acquire skills on methods of gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection.
4. Evaluate the Biotechnology method of disease management.
5. Analyze the gene-for-gene hypothesis R and Avr gene.
6. Examine the pathogenesis related proteins for induction of disease resistance.

21AG3121 PRINCIPLES AND PROCEDURES OF CERTIFICATION

Credits: 1(1+0)

Course Objectives:

Enable the students to:

1. Acquire knowledge on certification procedures for seed and planting material
2. Understand the National regulatory mechanism and seed certification standards
3. Impart knowledge on seed health testing procedures

Course Outcomes:

The students will be able to:

1. Comprehend seed certification and international scenario in certification system
2. Evaluate the basics for testing physical and genetic purity of seeds
3. Gain knowledge on quality control specifications in seed certification
4. Conceptualize the national status of seed health in seed certification
5. Apply the knowledge on accreditation procedures for seed testing laboratories
6. Analyze the role of seed certification in national and international trade

21AG3122 PLANT BIOSECURITY AND BIOSAFETY

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Gain the knowledge on Plant biosecurity and biosafety issues in agriculture.
2. Understand the International standards for phytosanitary measures and pest risk analysis
3. Acquire knowledge on Biosafety policies and regulatory mechanism

Course Outcomes:

The students will be able to:

1. Review on the history, concepts and components of biosecurity
2. Understand national regulatory mechanism and international agreements/ conventions
3. Conceptualize forecasting system and pest risk assessment models for plant biosecurity
4. Acquire skills on Global Positioning System and Geographic Information System in plant biosecurity
5. Administer knowledge on issues related to release of genetically modified crops.
6. Comprehend the Cartagena protocol on biosafety and its implications

21AG3123 ADVANCES IN NEMATODE MANAGEMENT

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Acquire knowledge about promising bio-control agents
2. Understand defense mechanisms on host nematode interaction
3. Gain knowledge on latest developments and trends in nematode management.

Course Outcomes:

The students will be able to:

1. Acquire skills on isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents.
2. Understand the mass culturing protocols of potential bio-control agents.
3. Conceptualize resistance mechanisms of host nematode interaction
4. Review nematode management modules for integrated pest and disease management in cropping systems.
5. Comprehend nematode management options and approaches for organic farming and precision farming.
6. Gain knowledge on application of GIS and GPS technology for surveillance and management.

21HO3127 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge on the basic principles of growth and development in horticultural crops.
2. Understand the biosynthesis of growth regulators and inhibitors in horticultural crops.
3. Exploit growth regulators including growth inhibitors for various purposes in horticultural crops.

Course Outcomes:

The students will be able to:

1. Define the fundamental concepts of growth and development physiology.
2. Narrate the biosynthesis of various growth regulators and inhibitors.
3. Relate the physiological problems caused with suitable correction measures.
4. Manage the ill effects of abiotic stress with suitable control measures.
5. Recommend suitable growth regulators for various objectives in the field.
6. Educate the farmer on suitable training and pruning methods for various crops.

21HO3128 TROPICAL AND DRY LAND FRUIT PRODUCTION

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the cultural requirements of tropical and dry land fruit crops.
2. Analyse the causes that limit the production of tropical and dryland fruit crops.
3. Gain knowledge on the potential for industrial exploitation and export opportunities of the fruit crops.

Course Outcomes:

The students will be able to:

1. Undertake cultivation of tropical and dry land fruit crops on scientific basis.
2. Undertake the production of elite planting material of major fruit crops with rootstocks suited for specific situations.
3. Upgrade the traditional orchards using the knowledge obtained.
4. Improve the quality of the final produce with application of suitable strategies.
5. Educate the farmers about modern methods of packing, storage and ripening.
6. Run their own fruit-based industries in crops like mango, banana, citrus and papaya.

21HO3129 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the importance of biodiversity conservation.
2. Learn the principles of biodiversity and strategies for germplasm conservation in fruit crops.
3. Gain knowledge on methods of conserving genetic resources in fruit crops.

Course Outcomes:

The students will be able to:

1. Realize the potential of germplasm in crop improvement.
2. Take up a career in research and development institutes.
3. Produce potential hybrids using native species in selected crops.
4. Own high tech conservation laboratories for the endangered species of selected crops.
5. Establish gene sanctuaries or biodiversity parks for future breeding works.
6. Run a business on genome sequencing on commercial basis.

21HO3130 PROPAGATION AND NURSERY MANAGEMENT OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the cellular basis of plant propagation.
2. Understand the principles of selection of mother plants for budding and grafting and issues related with.
3. Learn the principles, concepts and methods of *in vitro* propagation for various horticultural crops.

Course Outcomes:

The students will be able to:

1. Apply the principles and methods of asexual propagation successfully.
2. Run a seed industry after learning the issues associated with industry.
3. Take up rejuvenation of old and traditional orchards for upgradation.
4. Own a scion bank of elite varieties of commercial fruit crops in scientific manner.
5. Get employed in successful tissue culture labs or can run their own tissue culture labs.
6. Establish their own fruit nursery producing elite plants in major fruit growing tracts.

21HO3131 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the cultural requirements of subtropical and temperate fruit crops.
2. Analyse the factors that limit the production of subtropical and temperate fruit crops.
3. Gain knowledge on the potential for industrial exploitation and export opportunities of the crops.

Course Outcomes:

The students will be able to:

1. Undertake cultivation of crops mentioned here on scientific basis.
2. Undertake the production of elite planting material of major fruit crops with rootstocks suited for specific situations.
3. Upgrade the traditional orchards using the knowledge obtained.
4. Improve the quality of the final produce with application of suitable strategies.
5. Educate the farmers about modern methods of packing, storage and ripening.
6. Run their own fruit-based industries in crops like grapes, pomegranate, fig.

21HO3132 CANOPY MANAGEMENT IN FRUIT CROPS

Credits: 2 (1+1)

Course Objectives:

Enable the students to:

1. Understand the essential of canopy management in fruit crops.
2. Understand the various factors affecting canopy development in different fruit crops.

3. Understand the techniques and methods of canopy management.

Course Outcomes:

The students will be able to:

1. Apply the principles of canopy management in the field for yield improvement.
2. Educate the farmers about the benefits of canopy management.
3. Get employed in commercial orchards run by corporates.
4. Exploit the dwarfing rootstocks available for canopy management.
5. Recommend the strategies for canopy management through growth regulators.
6. Work out a planting design for different canopy styles.

21HO3133 BREEDING OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the taxonomy and cytogenetics of different fruit crops.
2. Learn the breeding objectives, systems and approaches for different fruit crops.
3. Gain knowledge on the achievements of breeding and future thrust in different fruit crops.

Course Outcomes:

The students will be able to:

1. Get acquainted with taxonomy and cytogenetics of fruit crops.
2. Get employed in research and development institutes.
3. Produce potential hybrids using native species in selected crops.
4. Develop resistant varieties using local genetic resources for biotic and abiotic stresses.
5. Take up a career in biotechnology industry.
6. Take up a job in extension for educating the farmers on new high yielding varieties and hybrids.

21HO3136 ADVANCES IN PRODUCTION OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge on recent advances in propagation and planting system.
2. Get acquainted with aspects of growth regulation.
3. Gain knowledge on influence of stress factors and their management.

Course Outcomes:

The students will be able to:

1. Illustrate the national and international scenario of fruit production
2. Deliver the recent concepts in planting systems.
3. Draw a plan for precision farming of different fruit crops with decision support system.
4. Apply the concepts of growth regulation in the research projects.
5. Have a comprehensive understanding of various stress factors and their management.
6. Work out a plan for efficient management of water and nutrient in fruit orchards.

21HO3137 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Perceive knowledge on the eco physiological influence on growth and development.
2. Get a thorough understanding of biosynthesis, absorption, translocation and influence of growth regulators on fruit crops.
3. Gain expertise on management of aspects like flower induction, flower drop, fruit setting, fruit maturity and fruit ripening.

Course Outcomes:

The students will be able to:

1. Work out a cropping program for different climatic conditions.
2. Get expertise in the biosynthesis, absorption, translocation and influence of growth regulators on fruit crops.

3. Draw a research program on root and canopy regulation.
4. Analyse the factors responsible for hormonal influence.
5. Design a plan for fertigated orchards under different planting systems.
6. Evolve a plan for efficient management of flowering related aspects and off-season production.

21HO3138 ADVANCES IN BREEDING OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the evolutionary mechanisms, adaptation and domestication of fruit crops.
2. Gain knowledge on recent advances in crop improvement of fruit crops.
3. Get exposed to molecular and transgenic approaches in improvement of selected fruit crops.

Course Outcomes:

The students will be able to:

1. Teach genetics of important traits and their inheritance pattern.
2. Exploit variations and spontaneous mutations.
3. Propose external funded projects on fruit breeding for management of biotic and abiotic stresses.
4. Understand evolutionary mechanisms, adaptations and domestication of different fruit crops.
5. Design a research project on fruit breeding on consultancy basis.
6. Get a position in high tech laboratories and have exposure to molecular breeding.

21HO3139 GENOMICS AND BIOINFORMATICS IN HORTICULTURE

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Handle genomic databases.
2. Sequence alignment and structure prediction.
3. Apply the tools of genomics and bioinformatics in 'omics'

Course Outcomes:

The students will be able to:

1. Identify a genome sequence and annotate its functions.
2. Design gene-based primers for target traits.
3. Perform the multiple sequence alignment to identify conserved regions.
4. Study the functional structure of a protein and its physiochemical properties.
5. Identify the coding and non-coding sequence of a gene.
6. Analyse the metabolic pathway beneath a trait to assist genomic assisted breeding.

21HO3140 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Classify stress and understand its impact on crop growth.
2. Perform crop modelling for stress situations.
3. Learn the techniques involved in stress management.

Course Outcomes:

The students will be able to:

1. Get knowledge on types and impact of stress on crop growth.
2. Discuss the metabolic changes induced by stress factors.
3. Get expertise in crop modelling for stress conditions.
4. Follow management practices to overcome stress in fruit crops.
5. Discuss on the water use efficiency.
6. Elucidate the crop growth sustainability indices.

21HO3141 ENVIRONMENTAL HORTICULTURE

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Analyse the environmental system and its impact on horticulture crops.
2. Learn the advances in environmental management of horticultural crops.
3. Devise strategies in pollution management of horticulture-based industries.

Course Outcomes:

The students will be able to:

1. Get acquainted with environmental systems and their impact on horticulture.
2. Discuss about the geochemical and hydrological cycles.
3. Outline the causes of global warming and its impact on horticulture.
4. Describe about the habitat ecology and conservation.
5. Follow waste management practices in horticulture-based industries.
6. Explain about the different environmental policies across the globe.

21HO3154 ADVANCES IN VEGETABLE PRODUCTION

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Explore the latest developments and trends in production technology of major tropical and subtropical vegetable crops.
2. Learn the strategies of protected cultivation and seedling production of vegetable crops.
3. Gain knowledge on post-harvest technologies and value addition in vegetable crops.

Course Outcomes:

The students will be able to:

1. Gain knowledge on the recent trends in production technology of vegetable crops
2. Identify the problems associated with vegetable cultivation and take up location specific advanced research programs
3. Enumerate the use of nanotechnology, biotechnology and IT tools in vegetable production
4. Demonstrate the use of new generation products and formulations in vegetable farming
5. Discuss the role of training, pruning and crop modulation procedures to enhance productivity of vegetable crops
6. Elucidate the methods of low cost, input efficient agro techniques to enhance productivity of vegetable crops

21HO3155 ADVANCES IN BREEDING OF VEGETABLE CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Explore the recent trends in breeding of tropical, subtropical and temperate vegetable crops grown in India
2. Learn the strategies of holistic breeding methods involving traditional and molecular methods of breeding
3. Utilize the biotechnological tools in vegetable breeding

Course Outcomes:

The students will be able to:

1. Understand the recent trends in breeding of vegetable crops
2. Identify the recent trends in breeding objectives of vegetable crops
3. Conduct research on the molecular markers in stress resistance breeding
4. Demonstrate the techniques of biotechnological tools in vegetable breeding
5. Develop strategies for improvement in vegetable crops
6. Develop strategies in breeding for climate change adaptation of vegetables

21HO3156 PROTECTED CULTIVATION OF VEGETABLE CROPS

Credits: 2 (1+1)

Course Objectives:

Enable the students to:

1. Explore the recent trends in production of vegetable crops under protected environmental conditions
2. Learn the strategies of developing location specific protected structures for vegetable cultivation
3. Analyse the techniques of crop management in protected cultivation

Course Outcomes:

The students will be able to:

1. Understand the recent trends in growing of vegetable crops under protected environmental conditions
2. Identify appropriate location specific protected structures for vegetable cultivation
3. Produce vegetable seeds and seedlings in protected structures
4. Demonstrate the appropriate agro-techniques in protected cultivation
5. Conduct research on nutrient and soil management in vegetable cultivation under protected structures
6. Designing appropriate protected structures

21HO3157 BIOTECHNOLOGY IN VEGETABLE CROPS

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Learn the recent trends in biotechnology tools for crop improvement of vegetable crops
2. Develop vegetable varieties with biotic and abiotic resistance
3. Utilize the biotechnological tools in vegetable breeding

Course Outcomes:

The students will be able to:

1. Understand the recent trends in biotechnological tools employed in crop improvement of vegetable crops
2. Identify the strategy for development of vegetable varieties with biotic and abiotic resistance
3. Utilize the traditional and modern methods of crop improvement in vegetables
4. Use molecular markers in research programs on vegetable breeding
5. Utilize nano products in vegetable production
6. Develop location specific varieties for climate change resilience

21HO3158 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS

Credits: 2 (1+1)

Course Objectives:

Enable the students to:

1. Learn the recent trends in the seed certification, processing and storage of vegetable crops
2. Explore the advances in physiological and biochemical process of seed aging
3. Study the techniques of seed production, seed treatment and packing

Course Outcomes:

The students will be able to:

1. Understand the recent trends in seed production technology of major vegetable crops
2. Explore the recent trends in research on seed deterioration
3. Gain knowledge on the procedures for seed certification
4. Demonstrate the techniques of seed treatment
5. Understand the role of new seed policy, seed industry and farmers in vegetable seed production
6. Undertake the measures for seed quality enhancement in vegetables

21HO3171 ADVANCES IN FLOWER PRODUCTION TECHNOLOGY

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Update on the latest developments in production technology and trade of flower crops

2. Get sensitized on commercial flower production under protected conditions
3. Get the latest developments on propagation and post-harvest technology of flower crops

Course Outcomes:**The students will be able to:**

1. Analyse the global scenario of cut flower production and trade for starting new ventures
2. Demonstrate the advanced propagation techniques of cut flower crops
3. Design and lay out the irrigation and nutrient application systems for cut flower crops
4. Apply the environmental parameters using advanced techniques in protected structures
5. Practice chemical regulation in cut flower crops
6. Establish and run commercial ventures in flower crops under protected structures

21HO3172 ADVANCES IN PROTECTED AND PRECISION FLORICULTURE**Credits: 2(1+1)****Course Objectives:****Enable the students to:**

1. Understand the scope of protected floriculture in India
2. Gain skills in precision floriculture under protected conditions
3. Familiarise with the post-harvest management and vase life extension in flower crops

Course Outcomes:

The student will be able to

1. Analyse the prospects of protected floriculture in India and scope for export
2. Demonstrate skills in protected cultivation of commercial flowers
3. Apply GIS and remote sensing in commercial floriculture
4. Practice advanced production technology in selected commercial flowers
5. Acquire skills in precision farming system of flower crops
6. Adopt the post-harvest management techniques in flower crops
7. Reddy, S., Janakiram, B., Balaji, T., Kulkarni, S and Misra, R. L. (2007). *High-Tech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

21HO3173 ADVANCES IN BREEDING OF FLOWER CROPS**Credits: 3(2+1)****Course Objectives:****Enable the students to:**

1. Familiarise with the various objectives and methods of breeding in flower crops
2. Understand various genetic mechanisms associated with flower yield and quality
3. Gain knowledge on specific breeding problems and achievements in flower crops

Course Outcomes:**The students will be able to:**

1. Analyse the various methods of breeding suitable for different flower crops
2. Frame the breeding objectives for flower crops
3. Demonstrate the *in-vitro* breeding of flower crops
4. Develop breeding objectives and strategies for biotic stress management in flower crops
5. Outline breeding objectives and strategies for abiotic stress management in flower crops
6. Practice hybridisation and mutation breeding in flower crops

21HO3174 ADVANCES IN LANDSCAPE ARCHITECTURE**Credits: 3(1+2)****Course Objectives:****Enable the students to:**

1. Update on the recent trends in landscape horticulture
2. Gain practical skills in landscape design and establishment
3. Familiarise with budget cost estimation

Course Outcomes:

The student will be able to

1. Relate knowledge gained in plant identification for selection of landscape plants
2. Acquire skills in landscape planning

3. Apply skills in landscape design through softwares
4. Demonstrate skills in layout and planting of landscape gardens
5. Analyze budget and project cost estimates of landscape projects
6. Start consultancy and contracting services for landscape projects

21HO3175 ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Update knowledge on advances in biochemistry of flowers
2. Understand physiology and biotechnology in flower crops
3. Familiarise with the biotechnological tools for improvement in flower crops

Course Outcomes:

The student will be able to

1. Analyze the physiology and biochemistry involved in formation of flower pigments
2. Utilise commercial floricultural products for bio colours and for their value addition
3. Adopt skills to employ biotechnological tools for management of biotic and abiotic stress in flower crops
4. Apply skills in analytical procedures for quantification and quality analysis in flower crops
5. Acquaint with *in vitro* procedures and practices in genetic engineering
6. Practice biotechnological skills for gainful employment

21HO3188 ADVANCES IN PRODUCTION OF PLANTATION CROPS

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Understand the status, importance and scope of plantation crops in National economy
2. Update knowledge on advanced production technology of plantation crops in India
3. Familiarise with the developments in post-harvest technology and value addition in plantation crops

Course Outcomes:

The students will be able to:

1. Analyse the economic potential of various plantation crops for production and processing
2. Select the appropriate varieties of plantation crops based on objectives of production
3. Demonstrate the propagation methods in plantation crops
4. Apply the skills for production technology and developing cropping systems based on plantation crops
5. Adopt advanced post-harvest practices and value addition in plantation crops for self-employment
6. Outline the GAP, GMP and HACCP practices in important plantation crops

21HO3189 ADVANCES IN SPICE PRODUCTION

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the status, importance and scope of Spice crops in National economy
2. Update knowledge on advanced production technology of spice crops in India
3. Familiarise with the developments in post-harvest technology and value addition in spice crops

Course Outcomes:

The students will be able to:

1. Analyse the economic potential of various spice crops for production and processing
2. Select the appropriate varieties of spice crops based on objectives of production
3. Demonstrate the propagation methods and production technology in spice crops
4. Apply the skills for developing cropping systems based on spice crops
5. Adopt advanced post-harvest practices and value addition in spice crops for self-employment
6. Relate the GAP, GMP and HACCP practices in important spice crops for export

21HO3190 ADVANCES IN MEDICINAL AND AROMATIC CROP PRODUCTION TECHNOLOGY

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Update the knowledge on the economic importance and scope of medicinal and aromatic crops grown in India
2. Familiarise with the genetic diversity, varietal wealth and economic use of medicinal and aromatic crops
3. Comprehend the production and post-harvest technology of medicinal and aromatic crops grown in India

Course Outcomes:

The student will be able to:

1. Develop skills in collection, conservation and cataloguing of medicinal and aromatic crops
2. Apply advanced research methods in medicinal and aromatic crops
3. Recommend important varieties of medicinal and aromatic crops for crop production
4. Demonstrate the production technology of medicinal and aromatic crops
5. Establish processing and value addition units in medicinal and aromatic crops
6. Relate the GAP, GCP and GMP practices in medicinal and aromatic crops for export

21HO3191 ADVANCES IN BREEDING OF PLANTATION CROPS AND SPICES

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Understand the principles and advances in crop improvement of plantation crops and spices
2. Familiarise with the advances in specific conventional breeding methods in plantation crops and spices
3. Update on the biotechnological and molecular approaches in breeding of plantation and spice crops

Course Outcomes:

The student will be able to:

1. Program crop improvement strategies in plantation and spice crops
2. Analyse the pollination and fertilization mechanisms in plantation and spice crops
3. Adopt the skills for resistant breeding in plantation and spice crops
4. Demonstrate laboratory analytical skills estimation of quality and processing characters of plantation crops and spices
5. Apply biotechnological and molecular tools in improvement of plantation and spice crops
6. Breed new varieties in plantation crops and spices

21HO3192 ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS

Credits: 3 (2+1)

Course Objectives:

Enable student to:

1. Understand the principles and advances in crop improvement of medicinal and aromatic plants
2. Familiarise with the advances in specific conventional breeding methods medicinal and aromatic plants
3. Update on the biotechnological and molecular approaches in breeding of medicinal and aromatic crops

Course Outcomes:

The students will be able to:

1. Select the species and cultivars of medicinal and aromatic crops for breeding
2. Program crop improvement strategies in Medicinal and aromatic crops
3. Analyze the genetic mechanism associated with secondary metabolites in medicinal and aromatic crops
4. Apply biotechnological and molecular tools in improvement of medicinal and aromatic crops
5. Demonstrate laboratory analytical skills estimation of quality and processing characters of medicinal and aromatic crops

6. Breed new varieties in medicinal and aromatic plants

21HO3206 PHYSIOLOGY OF RIPENING AND SENESENCE

Credits: 2 (1+1)

Course Objectives:

Enable the students to:

1. Acquire knowledge of environmental factors that control the ripening and senescence
2. Understand molecular and physiological mechanisms of senescence and ripening
3. Apply methods to manipulate ethylene biosynthetic pathway

Course Outcomes:

The students will be able to:

1. Summarize the internal factor and external factors that cause senescence and ripening
2. Elucidate the molecular mechanism of senescence and ripening
3. Enumerate the structural changes of cell during senescence and ripening
4. Describe the biosynthetic pathway of ethylene
5. Explain the physiological and biochemical changes take place during senescence and ripening
6. Describe the involvement of many types of enzymes during ripening of fruits

21HO3207 NOVEL PROCESSING TECHNOLOGIES FOR HORTICULTURAL PRODUCE

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge on recent advances made in the food processing industries
2. Familiarize with functional food and nutraceuticals
3. Gain knowledge on role of microbes in the food industry

Course Outcomes:

The students will be able to:

1. Elaborate the minimal processing concept of food
2. Enumerate the role of recent methods of food processing
3. Explain the benefits and advantages of making functional food and nutraceuticals
4. Enumerate the importance of genetically engineered microbes in food industry
5. Develop innovative methods of fortification of food
6. Acquire the skills on freeze preservation

21HO3208 ADVANCES IN LABORATORY TECHNIQUES IN POST-HARVEST TECHNOLOGY

Credits: 3 (1+2)

Course Objectives:

Enable the students to:

1. Gain knowledge on principles of food quality assurance
2. Familiarize with food grade, food laws and food standards
3. Gain exposure to the advanced techniques of food analysis

Course Outcomes:

The students will be able to:

1. Explain the techniques for food analysis
2. Differentiate the browning reactions from non-browning reaction
3. Analyze the different kinds of food additives
4. Demonstrate the non-destructive quality evaluation of food
5. Analyze the food through different types of chromatographic techniques
6. Elucidate the residual analysis of food

21HO3209 ADVANCES IN PACKAGING TECHNOLOGY OF HORTICULTURAL PRODUCE

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Familiarize with recent methods of packaging of horticultural produce
2. Understand the role of different packing materials

3. Familiarize with recycling methods of packing materials

Course Outcomes:

The students will be able to:

1. Apply advanced packaging technology for better quality of the horticulture produce
2. Enumerate the advantages of NMBP over to the conventional packaging materials
3. Describe the packaging and flavor interaction
4. Enumerate the time temperature indicators and maximizing its effectiveness
5. Design the packaging materials for predicting shelf life of horticultural produce
6. Evaluate the pesticide migration from packaging material to food

21HO3210 STORAGE TECHNIQUES AND SUPPLY/COLD CHAIN MANAGEMENT OF HORTICULTURAL PRODUCE

Credits: 3 (2+1)

Course Objectives:

Enable the students to:

1. Familiarize with recent methods of storage of horticulture produce
2. Understand functional food and nutraceuticals
3. Familiarize with supply chain management of horticulture produce

Course Outcomes:

The students will be able to:

1. Apply cold chain technology to enhance the shelf life of horticultural produce
2. Enumerate the role of modern methods of food storage
3. Explain the importance of supply chain management of food
4. Enumerate the importance of e-marketing strategies of horticultural produce
5. Develop innovative and low-cost methods for storage of food
6. Demonstrate various models in decision making

21AG3222 LIBRARY AND INFORMATION SERVICES

Credits: 1 (0+1)

Course Objectives:

Enable the students to:

1. Gain skills to trace information from libraries efficiently.
2. Understand information and knowledge resources.
3. Conduct literature survey.

Course Outcomes:

The students will be able to:

1. Utilize the library resources effectively.
2. Formulate information search strategies.
3. Apply modern tools for information search.
4. Document and store e-resources effectively.
5. Explore scientific data from Internet, OPAC and other search engines.
6. Track information from reference sources.

21AG3223 TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 1 (0+1)

Course Objectives:

Enable the students to:

1. Write dissertations and research papers.
2. Develop research proposals with clarity avoiding grammatical errors.
3. Acquire verbal communication skills in English.

Course Outcomes:

The students will be able to:

1. Understand the basics of English.
2. Communicate well in English.
3. Write thesis and research papers.
4. Review the research papers.

5. Make oral presentations on their dissertations.
6. Participate in Group Discussions and job interviews with confidence.

21AG3224 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 (1+0)

Course Objectives:

Enable the students to:

1. Become aware of IPR and related protection systems.
2. Register inventions/designs, in India and abroad.
3. Use IPR for wealth and value creation in a knowledge-based country.

Course Outcomes:

The students will be able to:

1. Understand GATT, WTO, TRIPs and WIPO for IPR protection.
2. Acquire patent and copyright for their innovative work.
3. Avoid plagiarism and attendant legal complications
4. Comply with laws governing IPR, Copy right and other related domain.
5. Formulate ITK strategies.
6. Achieve new innovative goals.

21AG3225 BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 1 (0+1)

Course Objectives:

Enable students to:

1. Understand basics of handling laboratory instruments.
2. Gain knowledge on the principles of common laboratory techniques.
3. Discern the Do's and Don'ts of laboratory techniques.

Course Outcomes:

The students will be able to:

1. Handle the laboratory equipment safely.
2. Prepare solutions of different concentrations and strengths.
3. Preparation and measuring the different pH solutions.
4. Apply media preparation techniques for micro propagation.
5. Test the viability of seeds and pollen grains.
6. Classify the flowering plants based on taxonomy.

21AG3226 AGRICULTURAL RESEARCH, RESEARCH ETHICS, AND RURAL DEVELOPMENT PROGRAMS

Credits: 1 (1+0)

Course Objectives:

Enable the students to:

1. Understand the functioning of Agricultural Research systems and ethics in the research process.
2. Become familiar with national and international level organizations involved in Agricultural Research.
3. Know rural development Programs and government policies.

Course Outcomes:

The students will be able to:

1. Become aware of national and international agricultural research systems and institutions.
2. Participate in international collaborations for doing research.
3. Follow the research ethics.
4. Analyze issues related to rural development programs.
5. Understand the rural development policies of the governments.
6. Develop a positive orientation towards working in non-governmental organizations (NGOs)

21AG3227 INTRODUCTION TO BIOINFORMATICS

Credits: 3(2+1)

Course objectives:

Enable the students to:

1. Understand the fundamental aspects of bioinformatics
2. Comprehend the basic principles of database searching
3. Applications of bioinformatics in various disciplines

Course outcomes:

The students will be able to:

1. Apply the basic concepts of bioinformatics
2. Identify the information resources for data analysis
3. Practice searches for primary and secondary databases
4. Acquire skills to create own database search protocols
5. Analyse bioinformatics software
6. Develop web-based analysis tools

21AG3232 CURRENT TOPICS IN NEMATODE DISEASE DEVELOPMENT AND HOST RESISTANCE

Credits: 3(2+1)

Course Objectives:

Enable the students to:

1. Gain knowledge on Plant- nematode interaction
2. Understand plant defense and resistance against nematode infection
3. Acquire knowledge on Biotechnological approaches for nematode disease management

Course Outcomes:

The students will be able to:

1. Comprehend the mechanisms of pathogenesis and changes induced by nematodes in plants
2. Review the induction of defense responses in plant system
3. Understand the genetic basis of plant resistance to nematodes
4. Acquire skills on biotechnological approaches in development of disease resistant plants
5. Interpret the conventional breeding techniques in nematode management
6. Gain knowledge about the influence of microorganisms on plant nematode interactions.

21AG3233 ADVANCED DESIGN OF EXPERIMENTS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Gain knowledge on advanced statistical designs
2. Develop layouts for the advanced designs
3. Analyse the field data and interpret the results.

Course Outcomes:

The students will be able to:

1. Explore the basic principles of advanced designs
2. Apply the principles of designs for framing the field layouts.
3. Analyze and select optimum experimental designs in research.
4. Collect the appropriate data from the experiment for the statistical analysis.
5. Interpret the results of the statistical analysis with appropriate suggestions.
6. Acquire skills to implement experimental designs in various field experiments.

21AG3235 MATHEMATICAL MODELING IN AGRICULTURAL SCIENCES

Credits: 2(1+1)

Course Objectives:

Enable the students to:

1. Understand the basic principles of mathematical modelling.
2. Gain knowledge in mathematical modelling methods and techniques.
3. Perceive the applications of mathematical modelling in agricultural research.

Course Outcomes:**The students will be able to:**

1. Acquire knowledge about the basic types and laws of matrices.
2. Conceptualize the basics of integral and differential calculus.
3. Analyse the different kinds of mathematical models.
4. Analyse and evaluate different growth models in agriculture.
5. Create the different yield response models.
6. Evaluate the results of the various mathematical models.

21AG3236 WEATHER FORECASTING METHODS AND YIELD PREDICTION**Credits: 3 (2+1)****Course Objectives:****Enable the students to:**

1. Relate weather forecasting and yield prediction using models.
2. Review different crop simulation models.
3. Know crop risk management strategies due to natural calamities

Course Outcomes:**The students will be able to:**

1. Understand the weather forecasting systems in relation to crop production.
2. Gain expertise in various methods of weather forecasts.
3. Understand the principles in crop simulation modelling.
4. Evaluate different crop simulation models.
5. Learn the details of crop yield prediction.
6. Compute measures for minimizing its risk in crop production.

21AG3240 ADVANCES IN AGRO-METEOROLOGY**Credits: 3(3+0)****Course Objectives:****Enable the students to:**

1. Comprehend agricultural meteorology and rainfall climatology.
2. Relate climatological approaches in designing cropping systems and crop weather models.
3. Know micro climatology and GIS

Course Outcomes:**The students will be able to:**

1. Understand the importance of agricultural meteorology, climate and weather
2. Enumerate climatological approaches in designing cropping systems
3. Understand crop weather relationships for efficient crop production and agro climate
4. Acquire knowledge on crop weather models
5. Describe various micro climate modification using crop geometry management
6. Discuss response farming and soil moisture dynamics

21AG3241 ADVANCES IN WEED MANAGEMENT**Credits: 3(3+0)****Course Objectives:****Enable the students to:**

1. Review weed management strategies and modern weed management techniques.
2. Appreciate herbicides and their selectivity.
3. Relate weed shift, herbicide resistant weeds and fate of herbicides in soil.

Course Outcomes:**The students will be able to:**

1. Identify the different types of weeds management strategies.
2. Understand the modern weed management techniques.
3. Enumerate mode of action of herbicides.
4. Understand herbicide selectivity.
5. Acquire knowledge on weed shift and fate of herbicides in soil.

6. Recognise herbicide resistance and herbicide persistence.

21AG3242 CROP WATER REQUIREMENTS AND IRRIGATION SCHEDULING

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Comprehend climatological approach on irrigation scheduling.
2. Relate crop coefficient and irrigation water requirements of crops.
3. Review irrigation scheduling and different approaches.

Course Outcomes:

The students will be able to:

1. Identify the different types of climatological nomenclatures for ET.
2. Understand crop coefficient and its types.
3. Enumerate factors affecting water requirement.
4. Recommend different methods of determining water requirement by crops.
5. Compute the relation between Irrigation Performance and Irrigation Scheduling.
6. Outline different indicators for irrigation scheduling.

21AG3243 ADVANCES IN CROPPING AND FARMING SYSTEMS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Comprehend cropping and farming system.
2. Review contingency crop planning and alternate farming system.
3. Perceive integrated farming system models for different agro eco-systems.

Course Outcomes:

The students will be able to:

1. Recommend ways to effectively manage resources under different cropping systems.
2. Develop deep insights on crop interactions under cropping systems.
3. Gain knowledge on alternate farming systems, no and low-cost technologies
4. Compute different farming system indices.
5. Imbibe knowledge on Integrated farming system models for different agro eco-systems.
6. Apply the knowledge of sustainable crop production in sustainable agriculture.

21AG3244 ADVANCES IN CROP PRODUCTION AND SYSTEM MODELING

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Review the recent concepts in crop production and systems approach.
2. Comprehend different management practices and their optimization.
3. Know the crop simulation models and advantages.

Course Outcomes:

The students will be able to:

1. Summarize the system agriculture and holistic approaches.
2. Acquire knowledge on physiological factors limiting crop yields.
3. Gain knowledge on protected agriculture and its concepts.
4. Describe the methods of stress management in fruit crops.
5. Elucidate crop modelling, its scope and utility.
6. Apply crop simulation models

21AG3245 ADVANCES IN SOIL FERTILITY AND CROP MANAGEMENT

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Relate soil fertility and sustainable agriculture.

2. Apprehend various composting technologies.
3. Review integrated nutrient management and advantages.

Course Outcomes:**The students will be able to:**

1. Understand the concepts of soil fertility and productivity.
2. Describe various land capability classifications.
3. Discuss on the soil health parameters.
4. Apply knowledge on various composting technologies.
5. Overview on nutrient use efficiency.
6. Enumerate integrated nutrient management technologies.

21AG3246 GENOMICS ASSISTED BREEDING IN CROPS**Credits: 3(3+0)****Course Objectives:****Enable the students to:**

1. Acquire knowledge in Advances in Genetics and Genomics
2. Review the dissection of key genes and proteins
3. Integrate Genome to phenome

Course Outcomes:**The students will be able to:**

1. Conceptualize the molecular description of nuclear and organellar genomes
2. Analyse the mechanism of genetic control over gene expression and regulation in plants
3. Develop trait associated markers and primers for molecular breeding
4. Incorporate the knowledge in sequencing techniques across generations
5. Analyse the strategies for TILLING and ECO-TILLING
6. Imply the bioinformatics tools, databases in advanced genomics

21AG3247 CYTOGENETICS AND CHROMOSOME MANIPULATION IN CROPS**Credits: 3(3+0)****Course Objectives:****Enable the students to:**

1. Evaluate the role of cellular organelles, chromosome structure, and telomeres in crop evolution and genetic regulation.
2. Apply cytogenetic techniques to locate genes and understand the role of polyploidy in crop breeding.
3. Explore genetic consequences of chromosomal aberrations and *in vitro* morphogenesis pathways for crop improvement.

Course Outcomes:**The students will be able to:**

1. Understand the role of cellular organelles and nuclear DNA organization in crop evolution and genetics.
2. Apply advanced cytogenetic techniques to locate and map genes and genomic segments for crop improvement.
3. Analyse genetic diversity within crop populations, including introns, exons, and transcription factors.
4. Utilize genetic tools like transposons and translocations to enhance crop breeding.
5. Evaluate chromosomal aberrations, breeding behaviour, and hybridization barriers in crop genetics.
6. Explore *in vitro* morphogenesis and apply it for stress-resistant crop breeding.

21AG3248 ADVANCED PLANT BREEDING SYSTEMS**Credits: 3(3+0)****Course Objectives:****Enable the students to:**

1. Understand the principles of Breeding and mating systems
2. Gain insight into Cytonuclear interactions and their manipulation
3. Acquire knowledge on advanced selection techniques and population improvement

Course Outcomes:

The students will be able to:

1. Conceptualize the evolutionary concepts of plant breeding
2. Apply the principles of plant breeding in developing breeding populations
3. Synthesize Mendelian and complex populations
4. Comprehend the selection principles for self- and cross-pollinated crops
5. Analyse different genetic engineering methods for developing male sterile populations
6. Generate new cyto-nuclear systems to diversify the male sterile systems

21AG3249 BIOMETRICAL TECHNIQUES IN CROP IMPROVEMENT

Credits: 2(2+0)

Course objectives:

Enable the students to:

1. Gain knowledge of theoretical and computation skills for estimating the components of variation
2. Evaluating the mating designs in plant breeding
3. Interpreting the gene action, scales and gene effects

Course Outcomes:

The students will be able to:

1. Apply suitable breeding procedures for trait-specific improvement
2. Examine the gene actions and selection indices for suitable parents
3. Adopt the designs of experiments involved in breeding programs
4. Evaluate the results effected in mating designs and analyse their statistical parameters
5. Develop mapping populations for QTL analysis and marker-assisted selection
6. Identify the marker-trait association and QTLs for specific traits

21AG3250 PLANT GENETIC RESOURCES AND ITS IMPORTANCE

Credits: 2(2+0)

Course objectives:

Enable students to:

1. Concepts of plant exploration and collection
2. Conservation practices of germplasm accessions
3. Understand the genetic enhancement techniques

Course Outcomes:

The students will be able to:

1. Evaluate the concept of gene centres and diversity hotspots
2. Apply the procedures in germplasm exchange, management and plant quarantine
3. Realize the importance of germplasm resources for genetic enhancement
4. Apply breeding and biotechnology tools for gene transfer
5. Analyse the intellectual property rights and their regulations

21AG3251 BREEDING FOR STRESS AND QUALITY TRAITS

Credits: 2(2+0)

Course objectives:

Enable the students to:

1. Realize the importance of Climate Resilient Varieties and hybrids
2. Understand the utilization of Wild relatives
3. Acquire knowledge on Biofortification of Food crops

Course Outcomes:

The students will be able to:

1. Identify and screen the tolerant and susceptible lines
2. Conceptualize the kinds of stresses and its impact in plant growth
3. Assess the nutrition in food and its enhancement by breeding
4. Evaluate the novel breeding techniques for stress tolerance in plants
5. Recognize the role of molecular tools in stress and quality breeding
6. Analyse the antinutritional factors in crops.

21AG3252 ADVANCED INSECT TAXONOMY

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Understand the insect classification, phylogenetics, classical and molecular methods.
2. Gain Knowledge on different groups of insects and International Code of Zoological Nomenclature.
3. Acquire knowledge on ethics and procedure for taxonomic publications.

Course Outcomes:

The students will be able to:

1. Understand about insect classification, evolutionary history and cladistics.
2. Relate with the International Code of Zoological Nomenclature, including appendices to ICZN-Ethics.
3. Comprehend the knowledge on the evolution of insects.
4. Apply the concept of phylocode.
5. Analyze the alternative naming systems for insects.
6. Acquire skills on molecular taxonomy and barcoding species.

21AG3253 INSECT TOXICOLOGY

Course Objectives:

Enable the students to:

1. Understand the latest advancements in the field of insecticide toxicology.
2. Gain knowledge on biochemical and physiological target sites of insecticides.
3. Acquire knowledge on pesticide resistance mechanisms in insects.

Course Outcomes:

The students will be able to:

1. Understand the penetration and distribution of insecticides in insect systems.
2. Evaluate the problems associated with pesticide residues in agriculture ecosystem.
3. Analyse the biochemical and physiological target sites of insecticides in insects.
4. Apply insecticide laws and standards, and good agricultural practices.
5. Acquire skills on biochemical and biological techniques for detection of insecticide resistance in insects.
6. Correlate different advanced methods for estimation of insecticide residues.

21AG3254 HOST PLANT RESISTANCE

Course Objectives:

Enable the students to:

1. Understand the recent advances in resistance of plants to insects.
2. Acquire knowledge on techniques for assessment and evaluation of resistance in crop plants.
3. Gain knowledge on biotechnological approaches in host plant resistance.

Course Outcomes:

The students will be able to:

1. Acquire skills on techniques and determination of categories of plant resistance.
2. Understand the importance of plant resistance.
3. Analyze the physical and chemical environment conferring resistance in plants.
4. Evaluate the mechanisms of resistance for orientation, feeding, oviposition etc.,
5. Identify the plant resistance based on genotype expression.
6. Apply the advanced biotechnological tools in host plant resistance.

21AG3255 BIOTECHNOLOGICAL APPROACHES IN ENTOMOLOGICAL RESEARCH

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Acquire knowledge on molecular techniques in entomological research.
2. Gain Knowledge on biotechnological approaches in sericulture and apiculture.
3. Understand genes of interest in entomological research.

Course Outcomes:**The students will be able to:**

1. Understand the techniques used in molecular biology.
2. Apply DNA and RNA analysis for identification of insects.
3. Identify and classify genes for characters of interest.
4. Examine the genetic improvement of natural enemies.
5. Acquire skills on insect gene transformation in relation to silkworms and honey bees.
6. Apply resistance management strategy in transgenic crops.

21AG3256 INTEGRATED INSECT PEST MANAGEMENT**Credits: 2(2+0)****Course Objectives:****Enable the students to:**

1. Understand recent problems with alien pest and use of IPM
2. Acquire knowledge on surveillance and data base management as a tool in IPM
3. Gain knowledge on successful national and international case histories of integrated pest management

Course Outcomes:**The students will be able to:**

1. Understand the principles and concepts of IPM
2. Acquire skills on data base management, simulation techniques and system analysis
3. Apply new technologies in genetic engineering and their progress and limitations in IPM Programs
4. Analyze the different strategies in pesticide resistance management.
5. Correlate with new technologies and their progress and limitations in IPM Programs
6. Evaluate the scope and limitations of bio-intensive and ecological based IPM Programs

21AG3257 BIOLOGICAL CONTROL OF INSECT PESTS**Credits: 2(2+0)****Course Objectives:****Enable the students to:**

1. Understand the role of biocontrol agents in pest management.
2. Acquire knowledge on advanced techniques for mass multiplication and field release of biocontrol agents.
3. Gain knowledge on scope of biocontrol agents in organic farming system.

Course Outcomes:**The students will be able to:**

1. Understand the scope of classical biological control and augmentative biocontrol.
2. Identify and classify the dynamics of biocontrol agents against target pest populations.
3. Acquire skills on mass culturing techniques of biocontrol agents.
4. Evaluate the scope of genetically engineered microbes and parasitoids in biological control.
5. Analyze the different method of application of biocontrol agents.
6. Apply the knowledge for overcoming insecticide resistance pest population using biocontrol agents.

21AG3258 ADVANCED MYCOLOGY**Credits: 3(3+0)****Course Objectives:****Enable the students to**

1. Understand the advances in molecular taxonomy of fungi
2. Acquire knowledge on Morphology and reproduction of fungi
3. Gain knowledge on pathogenic variability and heterokaryosis of fungi

Course Outcomes:**The students will be able to:**

1. Review the recent taxonomy of fungi.
2. Comprehend morphological and sexual characters of fungi

3. Analyze the population biology of fungi
4. Evaluate the variability of fungal pathogens
5. Conceptualize nuclear inheritance among fungal pathogens
6. Acquire skills on role of fungus in biodegradation

21AG3259 ADVANCED VIROLOGY

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Understand the Mechanism of virus infection.
2. Gain knowledge on antibody production technology.
3. Acquire knowledge about genome organization, replication, transcription and translational strategies.

Course Outcomes:

The students will be able to:

1. Comprehend the virus infection and replication.
2. Analyse the virus-vector relationship.
3. Apply the knowledge on development of immunodiagnostic kits.
4. Conceptualize various molecular tools for identification of pathogenic viruses.
5. Review the genomic organization of various plant viruses.
6. Acquire skills on genetic engineering with plant viruses, viral suppressors, an RNAi dynamics, resistant genes.

21AG3260 ADVANCED BACTERIOLOGY

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Gain knowledge on the latest taxonomy of phytopathogenic bacteria.
2. Understand the secretion systems of bacteria.
3. Review Host defense mechanism and genetic engineering for bacterial disease management

Course Outcomes:

The students will be able to:

1. Analyze the Host-bacterial pathogen interaction.
2. Correlate the factors responsible for disease spread.
3. Administer knowledge on molecular characterization of phytopathogenic bacteria
4. Conceptualize host defense mechanism.
5. Acquire skills of Genetic engineering for management of bacterial plant pathogens.
6. Evaluate the beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management.

21AG3261 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the advanced techniques in Molecular Plant Pathology.
2. Gain knowledge on the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.
3. Acquire knowledge on genetic engineering approach for management of plant disease.

Course Outcomes:

The students will be able to:

1. Conceptualize the mechanism of host-pathogen interactions.
2. Comprehend induced systemic resistance.
3. Acquire skills on methods of gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection.
4. Evaluate the Biotechnology method of disease management.
5. Analyze the gene-for-gene hypothesis R and Avr gene.

6. Examine the pathogenesis related proteins for induction of disease resistance.

21AG3262 PLANT BIOSECURITY AND BIOSAFETY

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the advances in plant biosecurity and biosafety
2. Acquire knowledge about plant quarantine regulations on pest and diseases
3. Administer knowledge about Integrated approaches on biosecurity and biosafety

Course Outcomes:

The students will be able to:

1. Comprehend the concept and components of biosecurity
2. Review national regulatory mechanism and international agreements
3. Gain knowledge about plant biosecurity, pests and diseases epidemic management
4. Evaluate the biosafety policies and regulatory mechanisms.
5. Analyze the different pest risk analysis, assessment models and pest information system.
6. Conceptualize advanced criteria for issues related to release of genetically modified crops.

21AG3263 PRINCIPLES AND PROCEDURES OF CERTIFICATION

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Gain knowledge on advanced techniques in certification and quality control
2. Evaluate national status of seed health in seed certification
3. Understand the role of seed/ planting material health certification in national and international trade.

Course Outcomes:

The students will be able to:

1. Understand the concept and procedures for seed certification
2. Review the national regulatory mechanism and minimum seed certification standards
3. Acquire skills related to techniques involved in certification of seeds, vegetative propagules and *in vitro* cultures
4. Evaluate the methods used in certification of seeds, vegetative propagules and *in vitro* cultures
5. Comprehend the limits for diseases and insect pests in certification and quality control programmes
6. Acquire knowledge on advanced techniques for testing genetic identity, physical purity, germination percentage and seed health

21HO3270 PRODUCTION TECHNOLOGY TRENDS IN FRUIT CROPS

Credits: 3 (3+0)

Course objectives:

Enable the students to:

1. Get familiar with recent advances in propagation and planting systems of fruit crops
2. Become knowledgeable on the influence and management of stress factors in fruit crops
3. Learn about various methods of growth regulation.

Course Outcomes:

The students will be able to:

1. Develop a model cropping system in fruit crops
2. Get acquainted with recent advances in propagation of fruit crops
3. Layout a precision farming design with decision support systems
4. Transfer the technologies like high density and ultra-high density planting systems in fruit crops
5. Demonstrate the techniques of efficient water and nutrient management in fruit crops
6. Deliver a protocol for the management of abiotic stress in fruit crops

21HO3271 ADVANCES IN GROWTH PHYSIOLOGY OF FRUIT CROPS

Credits: 3 (3+0)

Course Objectives:

Enable the students to:

1. Learn about the eco physiological influence on various aspects of fruit crops
2. Develop the canopy regulations techniques using physical and chemical methods
3. Demonstrate techniques for management of flower and fruit drop, fruit set, fruit thinning and fruit size improvement

Course Outcomes:**The students will be able to:**

1. Understand the eco-physiological influences on growth and development of fruit crops and develop suitable management techniques
2. Know about the structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants
3. Develop suitable growth regulation strategies by studying their physiological and biochemical effects
4. Design suitable root and canopy management techniques particularly for HDP and UHDP systems
5. Advise the farmers with recent techniques for prevention of flower and fruit drop, improvement of fruit set and fruit size
6. Develop research projects in fruit crops using molecular and genetic approaches of crop growth regulation

21HO3272 FRUIT CROP IMPROVEMENT**Credits: 3 (3+0)****Course Objectives:****Enable the students to:**

1. Learn about cytogenetics, cyto morphology, chemotaxonomy, genetics of important traits and their inheritance pattern
2. Get acquainted with recent advances in crop improvement of fruit crops
3. Describe and catalogue genetic resources and germplasm collections

The students will be able to:

1. Understand the evolutionary mechanisms, adaptation, domestication, genetics and cytogenetics of important economic traits
2. Manage the incompatibility systems in fruit crops
3. Undertake different methods of breeding like hybridization, mutation and polyploid breeding
4. Take up breeding for resistance and quality using wild genotypes
5. Describe and catalogue the various genetic resources in fruit crops
6. Master skills in *in vitro* breeding of selected fruit crops

21HO3273 GENETIC RESOURCE INFORMATICS IN HORTICULTURE**Credits: 2 (2+0)****Course Objectives:****Enable the students to:**

1. Handle genomic databases
2. Sequence alignment and structure prediction
3. Apply the tools of genomics and bioinformatics in 'omics'

Course Outcomes:**The students will be able to:**

1. Identify a genome sequence and annotate its functions
2. Design gene-based primers for target traits
3. Perform the multiple sequence alignment to identify conserved regions
4. Study the functional structure of a protein and its physiochemical properties
5. Identify the coding and non-coding sequence of a gene
6. Analyze the metabolic pathway beneath a trait to assist genomic assisted breeding

21HO3274 STRESS MANAGEMENT IN HORTICULTURAL CROPS**Credits: 2(2+0)****Course Objectives:****Enable the students to:**

1. Understand the definition, various types of stresses and crop physiology and biochemistry

associated with.

2. Analyse the plant stress factors, under varied stress situations.
3. Comprehend the influence of stress factors on plants biological efficiencies

Course Outcomes:

The students will be able to:

1. Identify and manage different stresses
2. Discuss the influence of stresses on the physiology and biochemistry of plants.
3. Assess water use efficiency, land use efficiency and nutrient use efficiency under various stresses
4. Evolve a suitable crop model for stress conditions
5. Get acquainted with the application of PGR and anti transpirants in stress management
6. Develop contingency plan to mitigate different stress situations

21HO3275 ENVIRONMENTAL SCIENCE IN RELATION TO HORTICULTURE

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the ecological changes in environment by horticulture crop production
2. Comprehend global warming and related issues
3. Work out a contingent plan to eliminate pollution in horticulture systems and effective waste management

Course Outcomes:

The students will be able to:

1. Assess the environmental changes by horticulture crop production
2. Gain knowledge on global warming, methane emission
3. Work out a contingent plan to manage pollution by horticultural crops
4. Develop skills for phytoremediation using appropriate plant species
5. Formulate farming systems that use natural resources sustainably
6. Get exposure on environmental policies at national and international levels and get suitable employment

21HO3276 RECENT TRENDS IN FLOWER CULTIVATION PRACTICES

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Update on the latest developments in production technology and trade of flower crops
2. Get sensitized on commercial flower production under protected conditions
3. Get the latest developments on propagation and post-harvest technology of flower crops

Course Outcomes:

The students will be able to:

1. Analyse the global scenario of cut flower production and trade for starting new ventures
2. Demonstrate the advanced propagation techniques of cut flower crops
3. Design and lay out the irrigation and nutrient application systems for cut flower crops
4. Apply the environmental parameters using advanced techniques in protected structures
5. Practice chemical regulation and value addition in cut flower crops
6. Establish and run commercial ventures in flower crops under protected structures

21HO3277 RECENT TRENDS IN BREEDING OF FLOWER CROPS

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Familiarise with the various objectives and methods of breeding in flower crops
2. Understand various genetic mechanisms associated with flower yield and quality
3. Gain knowledge on specific breeding problems and achievements in flower crops

Course Outcomes:

The students will be able to:

1. Analyse the various methods of breeding suitable for different flower crops
2. Frame the breeding objectives for flower crops
3. Demonstrate the *in-vitro* breeding of flower crops
4. Develop breeding objectives and strategies for biotic stress management in flower crops
5. Outline breeding objectives and strategies for abiotic stress management in flower crops
6. Practice hybridisation and mutation breeding in flower crops

21HO3278 ADVANCES IN LANDSCAPE ARCHITECTURE

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Update on the recent trends in landscape horticulture
2. Gain practical skills in landscape design and establishment
3. Familiarise with budget cost estimation

Course Outcomes:

The students will be able to:

1. Relate knowledge gained in plant identification for selection of landscape plants
2. Acquire skills in landscape planning
3. Apply skills in landscape design through softwares
4. Demonstrate skills in layout and planting of landscape gardens
5. Analyze budget and project cost estimates of landscape projects
6. Start consultancy and contracting services for landscape projects

21HO3279 RECENT TRENDS IN PROTECTED AND PRECISION FLORICULTURE

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the scope of protected floriculture in India
2. Gain skills in precision floriculture under protected conditions
3. Familiarise with the post-harvest management and vase life extension in flower crops

Course Outcomes:

The students will be able to:

1. Analyse the prospects of protected floriculture in India and scope for export
2. Demonstrate skills in protected cultivation of commercial flowers
3. Apply GIS and remote sensing in commercial floriculture
4. Practice advanced production technology in selected commercial flowers
5. Acquire skills in precision farming system of flower crops
6. Adopt the post-harvest management techniques in flower crops

21HO3280 RECENT TRENDS IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Update knowledge on advances in biochemistry of flowers
2. Understand physiology and biotechnology in flower crops
3. Familiarise with the biotechnological tools for improvement in flower crops

Course Outcomes:

The students will be able to:

1. Analyse the physiology and biochemistry involved in formation of flower pigments
2. Utilise commercial floricultural products for bio colours and for their value addition
3. Adopt skills to employ biotechnological tools for management of biotic and abiotic stress in flower crops
4. Apply skills in analytical procedures for quantification and quality analysis in flower crops
5. Acquaint with *in vitro* procedures and practices in genetic engineering
6. Practice biotechnological skills for gainful employment

21HO3281 CONTROL OF BIOTIC AND ABIOTIC STRESS IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand different types of stress and its effects in horticultural crops
2. Familiarise with the modelling of crops for various stress conditions
3. Formulate approaches involved in the stress management

Course Outcomes:

The students will be able to:

1. Analyse the causes and effects of various kinds of stresses in horticultural crops
2. Select horticultural crops suitable for various stress situations
3. Plan crop modelling strategies for stress conditions
4. Illustrate the methods of stress management in fruit crops
5. Evaluate adaptive features of horticultural crops under stress
6. Practice rainwater harvesting techniques

21HO3282 RECENT TRENDS IN VEGETABLE PRODUCTION

Credits: 3 (3+0)

Course Objectives:

Enable the students to:

1. Gain knowledge on recent developments and trends in production technology of major tropical and subtropical vegetables
2. Understand the strategies of protected cultivation and raising of vegetable seedlings
3. Study the latest techniques in processing and marketing of vegetables

Course Outcomes:

The students will be able to:

1. Apply the recent trends in production technology of vegetables
2. Identify the problems associated with vegetable cultivation and take up location specific advanced research programmes through breeding and biotechnological tools
3. Demonstrate the use of new generation products and formulations in vegetable farming to increase the productivity
4. Practice off season cultivation of vegetables for year-round production under protected structures.
5. Elucidate the methods of low cost, input efficient agro techniques to enhance productivity of vegetables
6. Implement the marketing strategies and postharvest techniques for successful production of vegetables.

21HO3283 RECENT TRENDS IN BREEDING OF VEGETABLE CROPS

Credits: 3 (3+0)

Course Objectives:

Enable the students to:

1. Study the recent trends in breeding of tropical, subtropical and temperate vegetable crops grown in India
2. Understand the strategies of holistic breeding methods which includes traditional and molecular methods
3. Gain knowledge on application of biotechnological tools in vegetable breeding

Course Outcomes:

The students will be able to:

1. Apply recent trends in breeding of vegetable crops with specific objectives
2. Practice use of molecular markers in biotic and abiotic stress resistance breeding
3. Demonstrate the techniques of biotechnological tools in vegetable breeding
4. Apply the role of holistic breeding strategy for vegetable improvement
5. Develop varieties or hybrids suitable for processing in vegetables
6. Utilize the breeding strategy to overcome climate change that helps in better adoption of vegetables

21HO3284 PROTECTED CULTIVATION OF VEGETABLE CROPS

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Learn recent trends in growing of vegetable crops under protected environmental conditions
2. Study the strategies of developing location specific protected structures for vegetable cultivation
3. Understand techniques of crop management in protected cultivation

Course Outcomes:

The students will be able to:

1. Apply the recent trends in growing of vegetable crops under protected environmental conditions
2. Identify appropriate location specific protected structures for vegetable cultivation
3. Produce the seeds and seedlings in protected structures
4. Demonstrate the appropriate agro-techniques in protected cultivation
5. Manage nutrient and soil for vegetable cultivation in protected structures
6. Design vegetable production model for appropriate protected structures

21HO3285 BIOTECHNOLOGY IN VEGETABLE CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Study the recent trends in biotechnology tools for crop improvement of vegetable crops
2. Gain knowledge on development of vegetable varieties with biotic and abiotic resistance
3. Understand the importance biotechnological tools in vegetable breeding

Course Outcomes:

The students will be able to:

1. Apply the recent trends in biotechnology tools employed in crop improvement of vegetable crops
2. Identify the strategy for development of vegetable varieties with biotic and abiotic resistance
3. Utilize the traditional and modern methods of crop improvement in vegetables
4. Demonstrate the use of molecular markers in vegetable breeding
5. Apply the role of nano products in vegetable production
6. Develop location specific varieties for climate change resilience

21HO3286 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the recent trends in the seed certification, processing and storage of vegetable crops
2. Learn the advances in physiological and biochemical process of seed aging
3. Study the techniques of seed production, seed treatment and packing

Course Outcomes:

The students will be able to:

1. Apply the recent trends in seed production technology of major vegetable crops
2. Practice recent trends in research on seed deterioration
3. Demonstrate the procedures for seed certification
4. Utilize the techniques of seed treatment and advances in research
5. Apply the role of seed industries and new seed policy in farming
6. Elucidate the measures for seed quality enhancement in vegetables

21HO3287 CONTROL OF BIOTIC AND ABIOTIC STRESS IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Learn the types of stress and its effects in horticultural crops
2. Understand the modelling of crops for various stress conditions
3. Study the approaches involved in the stress management

Course Outcomes:

The students will be able to:

1. Explain the classification of stress
2. Identify the metabolic changes induced by stress factors
3. Practice the crop modelling strategies for stress conditions
4. Illustrate the methods of stress management in Horticultural crops
5. Demonstrate the water use efficiency techniques in Horticultural crops
6. Apply the crop growth sustainability indices in various Horticultural crops

21HO3288 ADVANCES IN PRODUCTION TECHNOLOGY OF PLANTATION CROPS

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Understand the status, importance and scope of plantation crops in national economy
2. Update knowledge on advanced production technology of plantation crops in India
3. Familiarise with the developments in post-harvest technology and value addition in plantation crops

Course Outcomes:

The students will be able to:

1. Analyse the economic potential of various plantation crops for production and processing
2. Select the appropriate varieties of plantation crops based on objectives of production
3. Demonstrate the propagation methods in plantation crops
4. Apply the skills for production technology and developing cropping systems based on plantation crops
5. Adopt advanced post-harvest practices and value addition in plantation crops for self-employment
6. Outline the GAP, GMP and HACCP practices in important plantation crops

21HO3289 ADVANCES IN PRODUCTION TECHNOLOGY OF SPICE CROPS

Credits: 3(3+0)

Course Objectives:

Enable the students to:

1. Understand the status, importance and scope of spice crops in National economy
2. Update knowledge on advanced production technology of spice crops in India
3. Familiarise with the developments in post-harvest technology and value addition in spice crops

Course Outcomes:

The students will be able to:

1. Analyse the economic potential of various spice crops for production and processing
2. Select the appropriate varieties of spice crops based on objectives of production
3. Demonstrate the propagation methods and production technology in spice crops
4. Apply the skills for developing cropping systems based on spice crops
5. Adopt advanced post-harvest practices and value addition in spice crops for self-employment
6. Relate the GAP, GMP and HACCP practices in important spice crops for export

21HO3290 ADVANCES IN PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS

Credits: 3 (3+0)

Course Objectives:

Enable the students to:

1. Update the knowledge on the economic importance and scope of medicinal and aromatic crops grown in India
2. Familiarise with the genetic diversity, varietal wealth and economic use of medicinal and aromatic crops
3. Comprehend the production and post-harvest technology of medicinal and aromatic crops grown in India

Course Outcomes:

The students will be able to:

1. Develop skills in collection, conservation and cataloguing of medicinal and aromatic crops
2. Apply advanced research methods in medicinal and aromatic crops
3. Recommend important varieties of medicinal and aromatic crops for crop production
4. Demonstrate the production technology of medicinal and aromatic crops
5. Establish processing and value addition units in medicinal and aromatic crops
6. Relate the GAP, GCP and GMP practices in medicinal and aromatic crops for export

21HO3291 ADVANCES IN BREEDING METHODS OF PLANTATION AND SPICE CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the principles and advances in crop improvement of plantation crops and spices
2. Familiarise with the advances in specific conventional breeding methods in plantation crops and spices
3. Update on the biotechnological and molecular approaches in breeding of plantation and spice crops

Course Outcomes:

The students will be able to:

1. Plan crop improvement strategies in plantation and spice crops
2. Analyse the pollination and fertilization mechanisms in plantation and spice crops
3. Adopt the skills for resistant breeding in plantation and spice crops
4. Demonstrate laboratory analytical skills estimation of quality and processing characters of plantation crops and spices
5. Apply biotechnological and molecular tools in improvement of plantation and spice crops
6. Breed new varieties in plantation crops and spices

21HO3292 ADVANCES IN BREEDING METHODS OF MEDICINAL AND AROMATIC CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the principles and advances in crop improvement of medicinal and aromatic plants
2. Familiarise with the advances in specific conventional breeding methods in medicinal and aromatic plants
3. Update on the biotechnological and molecular approaches in breeding of medicinal and aromatic crops

Course Outcomes:

The students will be able to:

1. Select the species and cultivars of medicinal and aromatic crops for breeding
2. Plan crop improvement strategies in medicinal and aromatic crops
3. Analyze the genetic mechanism associated with secondary metabolites in medicinal and aromatic crops
4. Apply biotechnological and molecular tools in improvement of medicinal and aromatic crops
5. Demonstrate skills on estimation of quality and processing of medicinal and aromatic crops
6. Breed new varieties in medicinal and aromatic plants

21HO3293 ADVANCES IN BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Understand the definition, various types of stresses, crop physiology and biochemistry associated with.
2. Analyse the plant stress factors under varied stress situations
3. Comprehend the influence of stress factors on plants biological efficiencies

Course Outcomes:**The students will be able to:**

1. Identify and manage different stresses
2. Understand the influence of stresses on the physiology and biochemistry of crops
3. Develop crop modelling for stress situations
4. Analyse the plant stress factors and other physiological parameters
5. Understand the adaptive features of crops for survival under stress
6. Exploit different polymers and plant growth regulators for stress management

21HO3294 NOVEL PROCESSING TECHNOLOGIES FOR HORTICULTURAL PRODUCE**Credits: 3 (3+0)****Course Objectives:****Enable the students to:**

1. Understand the recent advances made in the food processing industries
2. Acquire knowledge on functional food and nutraceuticals
3. Gain knowledge on beneficial role of microbes in food industry

Course Outcomes:**The students will be able to:**

1. Elaborate the minimal processing concept of food
2. Enumerate the role of recent methods of food processing
3. Explain the benefits and advantages of making functional food and nutraceuticals
4. Enumerate the importance of genetically engineered microbes in food industry
5. Develop innovative methods of fortification of food
6. Acquire the skills on freeze preservation

21HO3295 ADVANCES IN LABORATORY TECHNIQUES IN POST-HARVEST TECHNOLOGY**Credits: 3 (3+0)****Course Objectives:****Enable the students to:**

1. Understand the principles of food quality assurance
2. Familiarize with food laws and food standards
3. Gain knowledge on advanced techniques of food analysis

Course Outcomes:**The students will be able to:**

1. Explain the techniques for food analysis
2. Differentiate the browning reactions from non-browning reaction
3. Analyse the different kinds of food additives
4. Demonstrate the non-destructive quality evaluation of food
5. Analyse the food through different types of Chromatographic techniques
6. Elucidate the residual analysis of food

21HO3296 MANAGEMENT OF STORAGE AND SUPPLY/COLD CHAIN TECHNIQUES OF HORTICULTURAL PRODUCE**Credits: 3(3+0)****Course Objectives:****Enable the students to:**

1. Familiarize with modern methods of storage of horticulture produce
2. Gain knowledge on supply chain inventory management
3. Familiarize with advanced supply chain management of horticulture produce

Course Outcomes:**The students will be able to:**

1. Apply cold chain technology to enhance the shelf life of horticultural produce
2. Enumerate the role of modern methods of food storage
3. Explain the importance of supply chain management of food
4. Enumerate the importance of e-marketing strategies of horticultural produce
5. Develop innovative and low-cost methods for storage of food

6. Demonstrate various models in decision making

21HO3297 ADVANCES IN THE PHYSIOLOGY OF RIPENING AND SENESENCE

Credits: 2 (2+0)

Course Objectives:

Enable the students to:

1. Understand the environmental control of ripening and senescence
2. Gain knowledge on molecular and physiological mechanisms of senescence and ripening
3. Acquire knowledge on methods to manipulate ethylene biosynthetic pathway

Course Outcomes:

The students will be able to:

1. Summarize the internal factor and external factors that cause senescence and ripening
2. Elucidate the molecular mechanism of senescence and ripening
3. Enumerate the structural changes of cell during senescence and ripening
4. Describe the biosynthetic pathway of ethylene
5. Explain the physiological and biochemical changes take place during senescence and ripening
6. Describe the involvement of many types of enzymes during ripening of fruits

21HO3298 MANAGEMENT OF BIOTIC AND ABIOTIC STRESS IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Gain knowledge on classification of stress and its impacts
2. Gain exposure to the crop modelling for stress situations
3. Familiarize with techniques involved in the stress management

Course Outcomes:

The students will be able to:

1. Summarize the classification of stress
2. Discuss the metabolic changes induced by stress factors
3. Enumerate the crop modelling for stress situations
4. Describe the methods of stress management in fruit crops
5. Discuss on the water use efficiency
6. Elucidate the crop growth sustainability indices

21HO3299 INNOVATIVE PACKAGING TECHNOLOGY FOR HORTICULTURAL PRODUCE

Credits: 2(2+0)

Course Objectives:

Enable the students to:

1. Gain exposure to advanced methods of packaging of horticultural produce
2. Understand the role of different packaging materials
3. Familiarize with the recycling of packaging materials

Course Outcomes:

The students will be able to:

1. Apply advanced packaging technology for better quality of the horticulture produce
2. Enumerate the advantages of NMBP over to the conventional packaging materials
3. Describe the packaging and flavour interaction
4. Enumerate the time temperature indicators and maximizing its effectiveness
5. Design the packaging materials for predicting shelf life of horticultural produce
6. Evaluate the pesticide migration from packaging material to food

LIST OF NEW COURSES

S. No.	Discipline	Course Code	Name of the Course	Credits
1	AGR	24AG3001	Modern Concepts in Crop Production	3(3+0)
2	AGR	24AG3002	Principles and Practices of Soil Fertility and Nutrient Management	3(2+1)
3	AGR	24AG3003	Principles and Practices of Weed Management	3(2+1)
4	AGR	24AG3004	Principles and Practices of Water Management	3(2+1)
5	AGR	24AG3006	Cropping Systems and Sustainable Agriculture	2(2+0)
6	AGR	24AG3007	Dryland Farming and Watershed Management	3(2+1)
7	AGR	24AG3008	Agronomy of Major Cereals and Pulses	3(2+1)
8	AGR	24AG3009	Agronomy of Oilseed, Fiber and Sugar crops	3(2+1)
9	AGR	24AG3010	Agronomy of Fodder and Forage Crops	3(2+1)
10	AGR	24AG3011	Conservation Agriculture	2(1+1)
11	AGR	24AG3012	Principles and Practices of Organic Farming	3(2+1)
12	AGR	24AG3013	Agronomy of Medicinal Aromatic and Underutilized Crops	3(2+1)
13	AGR	24AG3014	Agrostology and Agroforestry	3(2+1)
14	GPB	24AG3025	Principles of Genetics	3(2+1)
15	GPB	24AG3026	Principles of Cytogenetics	3(2+1)
16	GPB	24AG3027	Principles of Plant Breeding	3(2+1)
17	GPB	24AG3028	Fundamentals of Quantitative Genetics	3(2+1)
18	GPB	24AG3029	Molecular Breeding and Bioinformatics	3(2+1)
19	GPB	24AG3030	Hybrid Breeding	3(2+1)
20	GPB	24AG3031	Breeding for Quality and Special Traits	3(2+1)
21	GPB	24AG3032	Mutagenesis and Mutation Breeding	3(2+1)
22	GPB	24AG3033	Breeding for Stress Resistance and Climate Change	3(2+1)
23	GPB	24AG3034	Varietal Development and Maintenance Breeding	2(1+1)
24	GPB	24AG3035	Seed Production and Certification	2(1+1)
25	GPB	24AG3037	Crop Breeding-I (Kharif Crops)	3(2+1)
26	GPB	24AG3038	Crop Breeding-II (Rabi Crops)	3(2+1)
27	GPB	24AG3039	Breeding Vegetable Crops	3(2+1)
28	GPB	24AG3040	Breeding Fruit Crops	3(2+1)
29	GPB	24AG3041	Breeding Ornamental Crops	3(2+1)
30	GPB	24AG3042	Germplasm Characterization and Evaluation	2(1+1)
31	GPB	24AG3043	Genetic Enhancement for PGR Utilization	2(1+1)
32	FSC	24HO3127	Tropical Fruit Production	3(2+1)
33	FSC	24HO3128	Sub-Tropical and Temperate Fruit Production	3(2+1)
34	FSC	24HO3129	Propagation and Nursery Management of Fruit Crops	3(2+1)
35	FSC	24HO3130	Breeding of Fruit Crops	3(2+1)
36	FSC	24HO3131	Export Oriented Fruit Production	3(2+1)
37	FSC	24HO3132	Canopy Management in Fruit Crops	2(1+1)
38	FSC	24HO3133	Growth and Development of Fruit Crops	3(2+1)
39	FSC	24HO3135	Systematics of Fruit Crops	3(2+1)
40	FSC	24HO3136	Nutrition of Fruit Crops	3(2+1)
41	FSC	24HO3137	Biotechnology of Fruit Crops	3(2+1)
42	FSC	24HO3138	Organic Fruit Culture	3(2+1)
43	FSC	24HO3139	Climate Change and Fruit Crops	1(1+0)
44	FSC	24HO3140	Minor Fruit Production	3(2+1)
45	BTH	24AG3228	Physiological and Molecular responses of Plants to Abiotic Stresses	3(2+1)
46	SAC	24AG3227	Analytical Technique and Instrumental Methods in Soil and Plant Analysis	2(0+2)
47	AEC	24AG3217	Experimental Designs	3(2+1)

48	AGR	24AG3218	Remote Sensing and GIS Techniques for Soil and Crop Studies	3(2+1)
49	AEC	24AG3219	Data Analysis and Statistical Packages	3(2+1)
50	SAC	23AG3165	Microbial Gene Technology	3(2+1)
51	SAC	23AG3237	Comparative and Functional Genomics	2(1+1)

Course Code	Modern Concepts in Crop Production	L	T	P	C
24AG3001		3	0	0	3
Course Objectives:					
Enable the students to					
1. Comprehend the concepts of soil management and crop production					
2. Perceive the factors affecting crop production and yield					
3. Know the modern crop production technologies					
Course Outcomes:					
The students will be able to					
1. Understand the crop production techniques and crop growth in relation to environment					
2. Address various factors affecting crop production and yield					
3. Apprehend the effective ways of soil and nutrient management					
4. Recommend effective ways to overcome the environmental stresses affecting crop growth and yield					
5. Optimize effective utilization of farm resources, diversification of crop productions and maximizing the farm income					
6. Apply new technologies and trends in agriculture for maximizing crop yield and farm income in a sustainable way					
Theory					
Unit: I					
Crop growth analysis in relation to environment; geo-ecological zones of India.					
Unit: II					
Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.					
Unit: III					
Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modelling for desired crop yield.					
Unit: IV					
Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress, use of growth hormones and regulators for better adaptation in stressed condition.					
Unit: V					
Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture. Modern crop production concepts: soil less cultivation, Aeroponic, Hydroponic, Robotic and terrace farming. use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture.					
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Recommended by the Board of Studies	02.02.2024
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Course Code	Principles and Practices of Soil Fertility and Nutrient Management	L	T	P	C
24AG3002		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the fertility concepts of soil in relation to crop production 2. Gain knowledge on manures and fertilizers and its role in plant nutrition 3. Compute the Fertilizer Use efficiency and the economics of fertilizer use					
Course Outcomes:					
The students will be able to					
1. Comprehend the concepts of soil fertility and plant nutrition 2. Evaluate the soil nutrient status and plant nutrient content 3. Conceptualize the soil nutrient dynamics and plant uptake 4. Appreciate the importance of manures and fertilizers in crop production 5. Suggest nutrient recommendation based on soil fertility 6. Workout the economics of fertilizer use					
Theory					
Unit: I					
Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.					
Unit: II					
Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.					
Unit: III					
Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management. Soil less cultivation.					
Unit: IV					
Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency; agronomic, chemical and physiological, fertilizer mixtures and grades; methods of increasing fertilizer use efficiency; nutrient interactions.					
Unit: V					
Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic nutrients; economics of fertilizer use; integrated nutrient management; use of vermi-compost and residue wastes in crops.					
Practical					
Determination of soil pH and soil EC; Determination of soil organic C; Determination of available N, P, K and S of soil; Determination of total N, P, K and S of soil; Determination of total N, P, K, S in plant; Computation of optimum and economic yield					
References					
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Principles and Practices of Weed Management	L	T	P	C
24AG3003		2	0	1	3
Course Objectives:					
Enable the students to 1. Relate different types of weeds and its impact on crop production. 2. Know the herbicides and its application in weed control. 3. Perceive different methods of weed control in crop production.					
Course Outcomes:					
The students will be able to 1. Identify different types of weeds and their ecosystem. 2. Understand the weeds survival mechanisms. 3. Recommend herbicides for weed management in field crops. 4. Adopt different weed control methods for crop production. 5. Apply integrated weed management practices. 6. Workout the economics of weed control.					
Theory					
Unit: I					
Weed biology, and ecology and classification, crop-weed competition including allelopathy; principles and methods of weed control and classification management; weed indices, weed shift in different eco-systems					
Unit: II					
Herbicide's introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.					
Unit: III					
Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures, sequential application of herbicides, rotation; weed control through use of nano-herbicides and bio-herbicides, myco-herbicides bio-agents, and allelochemicals; movement of herbicides in soil and plant, Degradation of herbicides in soil and plants; herbicide resistance, residue, persistence and management; development of herbicide resistance in weeds and crops and their management, herbicide combination and rotation.					
Unit: IV					
Weed management in major crops and cropping systems; alien, invasive and parasitic, weeds and their management; weed shifts in cropping systems; aquatic and perennial weed control; weed control in non-crop area.					
Unit: V					
Integrated weed management; recent development in weed management- robotics, use of drones and aeroplanes, organic etc., cost: benefit analysis of weed management.					
Practical					
Identification of important weeds of different crops; preparation of a weed herbarium; weed survey in crops and cropping systems; crop-weed competition studies; preparation of spray solutions of herbicides for high and low-volume sprayers; study on various types of spray pumps and nozzles and calculation of swath width; economics of weed control; herbicide resistance analysis in plant and soil; bioassay of herbicide resistance; calculation of herbicidal requirement.					
References					
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Principles and Practices of Water Management	L	T	P	C
24AG3004		2	0	1	3
Course Objectives:					
Enable the students to 1. Comprehend the importance of water and its significance in crop production. 2. Relate the soil-water-plant relationships. 3. Know the different methods of irrigation management in crop production.					
Course Outcomes:					
The students will be able to 1. Understand the role of water in relation to metabolic and physiological functions of plants. 2. Optimize the water requirements for field crop cultivations. 3. Adopt different irrigation management strategies. 4. Apply the irrigation management principles for efficient water use. 5. Address different water management problems in irrigation. 6. Compute the layout of different irrigation systems.					
Theory					
Unit: I Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in of India and concerned state, major irrigation projects, extent of area and crops irrigated in India and in different states.					
Unit: II Field water cycle, water movement in soil and plants; transpiration; soil-water plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Water availability and its relationship with nutrient availability and loses.					
Unit: III Soil, plant and meteorological factors determining water needs of crops, scheduling, depth and methods of irrigation; micro irrigation systems; deficit irrigation; fertigation; management of water in controlled environments and polyhouses. Irrigation efficiency and water use efficiency.					
Unit: IV Water management of crop and cropping system, Quality of irrigation water and management of saline water for irrigation, water use efficiency, Crop water requirement- estimation of ET and effective rainfall; Water management of the major crops and cropping systems. Automated irrigation system.					
Unit: V Excess of soil water and plant growth; water management in problem soils, drainage requirement of crops and methods of field drainage, their layout and spacing; rain water management and its utilization for crop production.					
Unit: VI Quality of irrigation water and management of saline water for irrigation, water management in problem soils					
Unit: VII Soil moisture conservation, water harvesting, rain water management and its utilization for crop production					
Unit: VIII Hydroponics,					
Unit: IX Water management of crops under climate change scenario.					
Practical					

Determination of Field capacity by field method, Determination of Permanent Wilting Point by sunflower pot culture technique. Determination of Field capacity and Permanent Wilting Point by Pressure Plate Apparatus, Determination of Hygroscopic Coefficient, Determination of maximum water holding capacity of soil, Measurement of matric potential using gauge and mercury type tensiometer, Determination of soil-moisture characteristics curves, Determination of saturated hydraulic conductivity by constant and falling head Method Determination of hydraulic conductivity of saturated soil below the water table by auger hole method, Measurement of soil water diffusivity, Estimation of unsaturated hydraulic conductivity, Estimation of upward flux of water using tensiometer and from depth ground water table, Determination of irrigation requirement of crops (calculations), Determination of effective rainfall (calculations), Determination of ET of crops by soil moisture depletion method 16. Determination of water requirements of crops, Measurement of irrigation water by volume and velocity-area method, Measurement of irrigation water by measuring devices and calculation of irrigation efficiency Determination of infiltration rate by double ring infiltrometer.

References

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 4. Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.
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Course Code	Cropping Systems and Sustainable Agriculture	L	T	P	C
24AG3006		2	0	0	2

Course Objectives:

Enable the students to

1. Review the prevailing cropping systems in the country.
2. Appreciate the advanced agronomic practices for different cropping systems.
3. Know the sustainable agriculture practices

Course Outcomes:

The students will be able to

1. Understand different cropping systems and ways to effectively manage resources under different cropping systems.
2. Develop deep insights on crop interactions under cropping systems.
3. Gain knowledge on the importance of sustainable agriculture.
4. Evaluate sustainable agriculture with conventional agriculture in a scientific manner.
5. Optimize crop diversification and the sustainability of farm operations.
6. Recommend sustainable crop production practices for guiding farmers.

Theory

Unit: I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

Unit: II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

Unit: III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary, inputs and low-cost technologies; research need on sustainable agriculture

Unit: IV	
Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Advanced nutritional tools for big data analysis and interpretation.	
Unit: V	
Plant ideotypes for drylands; plant growth regulators and their role in sustainability.	
Unit: VI	
Artificial Intelligence- Concept and application.	
References	
1. Palaniappan, S.P and Sivaraman, K. (1996). <i>Cropping Systems in the Tropics; Principles and Management</i>. New Age. 2. Panda, S.C. (2018). <i>Cropping Systems and Sustainable Agriculture</i>. Agrobios 3. Panda, S.C. (2018). <i>Cropping and Farming Systems</i>. Agrobios. 4. Reddy, S.R. (2000). <i>Principles of Crop Production</i>. Kalyani Publications 5. Sankaran, S and Mudaliar, T.V.S. (1997). <i>Principles of Agronomy</i>. The Bangalore Printing and Publishing. Co. 6. Singh, S.S. (2006). <i>Principles and Practices of Agronomy</i>. Kalyani Publications. 7. Tisdale, S.L., Nelson, W.L., Beaton, J.D and Havlin, J.L. (1997). <i>Soil Fertility and Fertilizers</i>. Prentice Hall Publication.	
Recommended by the Board of Studies	02.02.2024
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Course Code	Dryland Farming and Watershed Management	L	T	P	C
24AG3007		2	0	1	3
Course Objectives:					
Enable the students to					
1. Perceive the basic concepts and practices of dryland farming.					
2. Comprehend the adaptation and mitigation strategies, crop planning and management techniques under dryland conditions.					
3. Review the soil moisture conservation and drought management.					
Course Outcomes:					
The students will be able to					
1. Understand the sustainable agriculture practices under dryland conditions.					
2. Correlate soil and climatic conditions of drylands for successful crop production.					
3. Recommend the various crop management techniques and the adaptation strategies for dry land agriculture.					
4. Formulate contingent water planning for aberrant weather conditions.					
5. Identify different types of watershed management strategies.					
6. Apply water conservation measures and water management strategies for dryland farming.					
Theory					
Unit: I					
Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.					
Unit: II					
Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.					
Unit: III					
Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.					
Unit: IV					
Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil					

moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use.

Unit: V

Concept of watershed resource management, problems, approach and components

Practical

Method of Seed Priming, Determination of moisture content of germination of important dryland crops, Determination of Relative Water Content and Saturation Deficit of Leaf Moisture stress effects and recovery behaviour of important crops, Estimation of Potential ET by Thornthwaite method, Estimation of Reference ET by Penman Monteith Method, Classification of climate by Thornthwaite method (based on moisture index, humidity index and aridity index), Classification of climate by Koppen Method, Estimation of water balance by Thornthwaite method, Estimation of water balance by FAO method, Assessment of drought, Estimation of length of growing period, Estimation of probability of rain and crop planning for different drought condition, Spray of anti-transpirants and their effect on crops, Water use efficiency, Visit to dryland research stations and watershed projects

References

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Course Code	Agronomy of Major Cereals and Pulses	L	T	P	C
24AG3008		2	0	1	3

Course Objectives:

Enable the students to

1. Comprehend cereals and pulses cultivated in India.
2. Know the crop husbandry of cereals and pulses.
3. Review the growth indices of cereals and pulses cultivated in India

Course Outcomes:

The students will be able to

1. Understand the geographical distribution, varietal improvements and the adaptability of major cereals and pulses cultivated in India
2. Acquire knowledge on crop production technologies for rabi cereals.
3. Practice crop production technologies for kharif cereals.
4. Manage the crop production technologies for rabi pulses.
5. Work out the crop production technologies for kharif pulses.
6. Apply the acquired knowledge to guide the farmers for cultivating cereals and pulses.

Theory

Unit: I

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of: <i>Rabi</i> cereals.	
Unit: II	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of: <i>Kharif</i> cereals.	
Unit: III	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of: <i>Rabi</i> pulses.	
Unit: IV	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of: <i>Kharif</i> pulses.	
Practical	
Phenological studies at different growth stages of crop; Estimation of crop yield on the basis of yield attributes; Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; Working out growth indices (CER, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops; Estimation of protein content in pulses; Planning and layout of field experiments; Judging of physiological maturity in different crops. Intercultural operations in different crops; Determination of cost of cultivation of different crops; Working out harvest index of various crops; Study of seed production techniques in various crops; Visit of field experiments on cultural, fertilizer, weed control and water management aspects; Visit to nearby villages for identification of constraints in crop production.	
References	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Agronomy of Oilseed, Fiber and Sugar Crops	L	T	P	C
24AG3009		2	0	1	3
Course Objectives:					
Enable the students to					
1. Comprehend oilseed, fibre and sugar crops cultivated in India.					
2. Know the crop husbandry of oilseed, fibre and sugar crops.					
3. Review the growth indices of oilseed, fibre and sugar crops.					
Course Outcomes:					
The students will be able to					
1. Understand the geographical distribution, varietal improvements and the adaptability of major oilseed, fibre and sugar crops cultivated in India.					
2. Acquire knowledge on crop production technologies for rabi oilseeds.					

3. Practice crop production technologies for kharif oilseeds. 4. Implement crop production technologies for fibre crops. 5. Work out crop production technologies for sugar crops. 6. Apply the acquired knowledge to guide the farmers for cultivating oilseed, fibre and sugar crops.	
Theory	
Unit: I	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality component, handling and processing of the produce for maximum production of: <i>Rabi</i> oilseeds – Rapeseed and mustard, Linseed and Niger	
Unit: II	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality component, handling and processing of the produce for maximum production of: <i>Kharif</i> oilseeds - Groundnut, Sesame, Castor, Sunflower, Soybean and Safflower	
Unit: III	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality component, handling and processing of the produce for maximum production of: Fiber crops - Cotton, Jute, Ramie and Mesta	
Unit: IV	
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality component, handling and processing of the produce for maximum production of: Sugar crops – Sugar-beet and Sugarcane.	
Practical	
Planning and layout of field experiments, Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane, Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice phenological studies at different growth stages of crop, Intercultural operations in different crops Cotton seed treatment, Working out growth indices (CGR, RGR, NAR, LAI, LAD, LAR, LWR, SLA, SLW etc), Assessment of land use and yield advantage (Rotational intensity, Cropping intensity, Diversity Index, Sustainable Yield Index Crop Equivalent Yield, Land, Equivalent ration, Aggressiveness, Relative Crowding Coefficient, Competition Ratio and ATER etc), Judging of physiological maturity in different crops and working out harvest index, Working out cost of cultivation of different crops, Estimation of crop yield on the basis of yield attributes, Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities Determination of oil content in oilseeds and computation of oil yield, Estimation of quality of fibre of different fibre crops, Study of seed production techniques in various crops, Visit of field experiments on cultural, fertilizer, weed control and water management aspects, Visit to nearby villages for identification of constraints in crop production.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Agronomy of Fodder and Forage Crops	L	T	P	C
24AG3010		2	0	1	3
Course Objectives:					
Enable the students to					
1. Comprehend the crop husbandry of different forage and fodder crops.					
2. Review the preservation of fodder crops.					
3. Appreciate the processing and value addition in forage and fodder crops.					

Course Outcomes:	
The students will be able to	
1. Evaluate the adaptation, distribution, varietal improvements and quality characteristics of fodder crops. 2. Recognise the significance of forage crops.	
3. Acquire knowledge on crop production technologies for different fodder crops and forage crops. 4. Perceive the methods of preserving the fodders. 5. Understand the methods of processing and enrichment of fodders. 6. Recommend different fodder and forage crops in reference to the nutritive values and animal health.	
Theory	
Unit: I	
Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like sorghum, maize, <i>bajra</i> , <i>guar</i> , cowpea, oats, barley, berseem, <i>senji</i> , lucerne, etc.	
Unit: II	
Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses/lime, Napier grass, <i>Panicum</i> , <i>Lasiurus</i> , <i>Cenchrus</i> , etc.	
Unit: III	
Year-round fodder production and management, preservation and utilization of forage and pasture crops.	
Unit: IV	
Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor-quality fodder. Fodder production through hydroponics. Azolla cultivation.	
Unit: V	
Economics of forage cultivation uses and seed production techniques of important fodder crops.	
Practical	
Practical training of farm operations in raising fodder crops, Canopy measurement, yield, Leaf: Stem ratio and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose and IVDMD, etc. of various fodder and forage crops, Anti-quality components like HCN in sorghum and such factors in other crops, Hay and silage making and economics of their preparation	
References	
1. Chatterjee, B.N. (1989). <i>Forage Crop Production-Principles and Practices</i>. Oxford and IBH Publication. 2. Das, N.R. (2007). <i>Introduction to Crops of India</i>. Scientific Publications. 3. Narayanan, T.R and Dabadghao, P.M. (1972). <i>Forage Crops of India</i>. ICAR. 4. Singh, P and Srivastava, A.K. (1990). <i>Forage Production Technology</i>. IGFRI, Jhansi. 5. Singh, C., Singh, P and Singh, R. (2003). <i>Modern Techniques of Raising Field Crops</i>. Oxford and IBH Publication. 6. Tejwani, K.G. (1994). <i>Agroforestry in India</i>. Oxford and IBH Publication.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Conservation Agriculture	L	T	P	C
24AG3011		1	0	1	2
Course Objectives:					
Enable the students to					
1. Gain knowledge on conservation agriculture systems					
2. Acquire skills on input and residue management of crops					
3. Implement practices to overcome climate change through integrated crop and soil health management					
Course Outcomes:					

The students will be able to	
1. Comprehend the scope and status of conservation agriculture 2. Analyze various strategies in nutrient, water, weeds, pest, disease and cover crop management 3. Evaluate C-sequestration procedures for soil and crop health 4. Integrate various aspects of sustainability in Agroforestry for dryland regions 5. Acquaint the techniques of calibrating farm machineries for conservation Agriculture 6. Compute the economical considerations of Conservation Agriculture	
Theory	
Unit: I	
Conventional and conservation agriculture systems, sustainability concerns, conservation agriculture: Historical background and present concept, global experiences, present status in India	
Unit: II	
Nutrient management in CA, water management, weed management, energy use, insect-pest and disease management, farm machinery, crop residue management, cover crop management.	
Unit: III	
Climate change mitigation and CA, C-sequestration, soil health management, soil microbes and CA.	
Unit: IV	
CA in agroforestry systems, rainfed / dryland regions	
Unit: V	
Economic considerations in CA, adoption and constraints, CA: The future of agriculture	
Practical	
Study of long-term experiments on CA. Evaluation of soil health parameters, Estimation of C-sequestration, Machinery calibration for sowing different crops, weed seedbank estimation under CA, energy requirements, economic analysis of CA.	
References	
1. Arakeri HR and Roy D. 1984. <i>Principles of Soil Conservation and Water Management</i>. Oxford & IBH. 2. Bisht JK, Meena VS, Mishra PK and Pattanayak A. 2016. Conservation Agriculture-An approach to combat climate change in Indian Himalaya. Publisher: Springer Nature. Doi: 10.1007/978-981-10-2558-7. 3. Dhruvanarayana VV. 1993. <i>Soil and Water Conservation Research in India</i>. ICAR. 4. FAO. 2004. <i>Soil and Water Conservation in Semi-Arid Areas</i>. Soils Bull., Paper 57. 5. Gracia-Torres L, Benites J, Martinez-Vilela A and Holgado-Cabera A. 2003. Conservation Agriculture- Environment Farmers experiences, innovations Socio-economic policy. 6. Muhammad F and Kamdambot HMS. 2014. Conservation Agriculture. Publisher: Springer Cham Heidelberg, New York Dordrecht London. Doi: 10.1007/978-3-319-11620-4. 7. Yellamanda Reddy T and Sankara Reddy GH. 1992. <i>Principles of Agronomy</i>. Kalyani.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Principles and Practices of Organic Farming	L	T	P	C
24AG3012		2	0	1	3
Course Objectives:					
Enable the students to					
1. Comprehend the concept of organic farming.					
2. Appreciate the agronomic practices and farming techniques under organic farming.					
3. Be familiar with the certification and marketing of organic produce.					
Course Outcomes:					
The students will be able to					
1. Relate organic farming and its relevance to Indian and global agriculture scenarios.					
2. Understand the crop management practices and technologies for organic crop production.					
3. Derive insights on soil fertility, nutrient cycle and soil biota.					
4. Compare the organic crop production with inorganic crop production.					
5. Apply the knowledge of standards and certification process in organic production.					
6. Analyse different marketing strategies of organic farm products.					

Theory	
Unit: I	
Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; principles of organic agriculture; organics and farming standards; organic farming and sustainable agriculture; selection and conversion of land, soil and water management - land use, conservation tillage; shelter zones, hedges, pasture management, agro-forestry	
Unit: II	
Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures, bio-fertilizers and biogas technology	
Unit: III	
Farming systems, selection of crops and crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.	
Unit: IV	
Control of weeds, diseases and insect pest management, biological agents and pheromones, bio-pesticides.	
Unit: V	
Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.	
Practical	
Method of making compost by aerobic method • Method of making compost by anaerobic method • Method of making vermicompost • Identification and nursery raising of important agro-forestry trees and trees for shelter belts • Efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field • Visit to a biogas plant • Visit to an organic farm • Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms	
References	
1. Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH. 2. Gaur AC. 1982. A Manual of Rural Composting, FAO/UNDP Regional Project Document, FAO. 3. Joshi M. 2016. New Vistas of Organic Farming. Scientific Publishers • Lampin N. 1990. Organic Farming. Press Books, Ipswich, UK. 4. Palaniappan SP and Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ. 5. Rao BV Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, Parisaraprajna Parishtana, Bangalore. 6. Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH. 7. Sharma A. 2002. Hand Book of Organic Farming. Agrobios. 8. Singh SP. (Ed.). 1994. Technology for Production of Natural Enemies. PDBC, Bangalore. • Subba Rao NS. 2002. Soil Microbiology. Oxford & IBH. 9. Trivedi RN. 1993. A Text Book of Environmental Sciences, Anmol Publ. • Veeresh GK, Shivashankar K and Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore. 10. WHO. 1990. Public Health Impact of Pesticides Used in Agriculture. WHO. 11. Woolmer PL and Swift MJ. 1994. The Biological Management of Tropical Soil Fertility. TSBF & Wiley	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Agronomy of Medicinal, Aromatic and Underutilized Crops	L	T	P	C
24AG3013		2	0	1	3
Course Objectives:					
Enable the students to					
1. Comprehend the importance of medicinal and aromatic plants in human health					
2. Review the practices and requirements for medicinal plants					

3. Acquaint knowledge on post harvest processing, grading, packing, storage, value addition and quality standards in herbal products.	
Course Outcomes:	
The students will be able to 1. Recognise the significance of Medicinal and Aromatic plants 2. Evaluate the adaptation, distribution, requirements and quality characteristics of medicinal and aromatic crops. 3. Acquire knowledge on crop production technologies for different medicinal and aromatic crops. 4. Perceive the methods of developing herbal products through post-harvest value addition processes 5. Analyze the methods of processing, grading and packaging of medicinal and aromatic products 6. Popularize different medicinal and aromatic crops in reference to the nutritive values and health	
Theory	
Unit: I	
Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge.	
Unit: II	
Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Mulhati, Isabgol, Rauwolfia, Poppy, Aloe vera, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, Nuxvomica, Rosadle, etc).	
Unit: III	
Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium).	
Unit: IV	
Climate and soil requirements; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco).	
Unit: V	
Post harvest handling –drawing, processing, grading, packing and storage, value addition and quality standards in herbal products.	
Practical	
Identification of crops based on morphological and seed characteristics. Raising of herbarium of medicinal, aromatic and under-utilized plants. Quality characters in medicinal and aromatic plants. Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants.	
References	
12. Chadha KL and Gupta R. 1995. <i>Advances in Horticulture</i>. Vol. II. <i>Medicinal and Aromatic Plants</i>. Malhotra Publ. 13. Das NR. 2007. <i>Introduction to Crops of India</i>. Scientific Publ. 14. Handa SS. 1984. <i>Cultivation and Utilization of Medicinal Plants</i>. RRL, CSIR, Jammu. 15. Hussain A. 1984. <i>Essential Oil Plants and their Cultivation</i>. CIMAP, Lucknow. 16. Hussain A. 1993. <i>Medicinal Plants and their Cultivation</i>. CIMAP, Lucknow. 17. ICAR 2006. <i>Hand Book of Agriculture</i>. ICAR, New Delhi. 18. Kumar N, Khader Md. Abdul, Rangaswami JBM & Irulappan 1997. <i>Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants</i>. Oxford & IBH. 19. Prajapati ND, Purohit SS, Sharma AK and Kumar T. 2003. <i>A Hand Book of Medicinal Plants: A Complete Source Book</i>. Agrobios. 20. Sharma R. 2004. <i>Agro-Techniques of Medicinal Plants</i>. Daya Publ. House.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Agrostology and Agroforestry	L	T	P	C
24AG3014		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on grassland ecosystems.					
2. Review the importance of Agroforestry systems in sustaining the land productivity.					
3. Adopt standard crop production technologies in agro-forestry and agrostology systems					
Course Outcomes:					
The students will be able to					
1. Comprehend the grassland ecosystem and its importance in India					
2. Perceive the importance of renovation, establishment and management of grasslands.					
3. Apply the practices of agrostology and pasture management in guiding farmers.					
4. Analyze the agroforestry systems and its impact in sustainable crop production.					
5. Implement the crop production technologies under agro-forestry systems.					
6. Integrate Agro-forestry and Agrostology in lands for sustainable production					
Theory					
Unit: I					
Agrostology: definition and importance; principles of grassland ecology: grassland ecology – community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.					
Unit: II					
Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses.					
Unit: III					
Agroforestry: definition and importance; agroforestry systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aquasilviculture, alley cropping and energy plantation.					
Unit: IV					
Crop production technology in agro-forestry and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agroforestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.					
Practical					
Preparation of charts and maps of India showing different types of pastures and agro-forestry systems. Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry. Seed treatment for better germination of farm vegetation. Methods of propagation/ planting of grasses and trees in silvipastoral system. Fertilizer application in strip and silvipastroal systems. After-care of plantation. Estimation of protein content in loppings of important fodder trees. Estimation of calorie value of wood of important fuel trees. Estimation of total biomass and fuel wood. Economics of agro-forestry. Visit to important agro-forestry research stations					
References					
1. Chatterjee BN and Das PK. 1989. <i>Forage Crop Production. Principles and Practices</i> . Oxford & IBH.					
2. Dabadghao PM and Shankaranarayan KA. 1973. <i>The Grass Cover in India</i> . ICAR.					
3. Dwivedi AP. 1992. <i>Agroforestry- Principles and Practices</i> . Oxford & IBH.					
4. Indian Society of Agronomy. 1989. <i>Agroforestry System in India. Research and Development</i> , New Delhi.					
5. Narayan TR and Dabadghao PM. 1972. <i>Forage Crop of India</i> . ICAR, New Delhi.					
Recommended by the Board of Studies		02.02.2024			
Approved by the Academic Council		24.02.2024			

Course Code	Principles of Genetics	L	T	P	C
24AG3025		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand genetic inheritance principles for problem-solving. 2. Apply genetic techniques proficiently for data analysis. 3. Evaluate ethical implications of genetics in research and biotechnology.					
Course Outcomes:					
The students will be able to 1. Demonstrate a comprehensive understanding of genetic inheritance principles. 2. Apply molecular techniques for genetic analysis. 3. Interpret genetic data using statistical methods. 4. Acquire the advanced techniques in gene isolation, synthesis and cloning. 5. Analyze the concept of gene silencing, DNA restriction and sequencing techniques. 6. Examine the polymorphisms in DNA and proteins.					
Theory					
Unit: I					
Beginning of genetics, early concepts of inheritance, Mendel’s laws; Discussion on Mendel’s paper, Chromosomal theory of inheritance; Multiple alleles, Gene interactions, Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.					
Unit: II					
Mendelian population, Random mating population, Frequencies of genes and genotypes, Causes of change: Hardy-Weinberg equilibrium.					
Unit: III					
Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis, Genetic fine structure analysis, Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Regulation of gene activity in prokaryotes and eukaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression, RNA editing.					
Unit: IV					
Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).					
Unit: V					
Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.					
Practical					
Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three-point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification; Electrophoresis: basic principles and running of amplified DNA; Extraction of proteins and isozymes; Use of Agrobacterium mediated method and Biolistic gun; Detection of transgenes in the exposed plant material; Visit to transgenic glasshouse and learning the practical considerations.					
References					
1. Daniel LH and Maryellen R. 2011. Genetics: “Analysis of Genes and Genomes”. 2. Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006. 3. Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education India; Tenth edition 4. Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018. 5. Russell PJ. 1998. Genetics. The Benjamin/ Cummings Publ. Co. 6. Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition)					

7. Snustad DP and Simmons MJ. 2006. Genetics. 4 th Ed. John Wiley and Sons. 6 th Edition International Student Version edition	
8. Stansfield WD. 1991. Genetics. Schaum Outline Series Mc Graw Hill.	
9. Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3 rd ed., 2015.	
10. Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7 th edition.	
11. Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Principles of Cytogenetics			L	T	P	C
24AG3026				2	0	1	3
Course Objectives:							
Enable the students to							
1. Analyze chromosomal architecture and variations in evolution.							
2. Utilize chromosome mapping techniques and cytological knowledge in practical applications.							
3. Evaluate the genetic consequences of polyploidization.							
Course Outcomes:							
The students will be able to							
1. Analyze chromosome structures in various organisms for functional insights.							
2. Demonstrate proficiency in cytogenetic techniques for chromosomal manipulation.							
3. Apply chromosomal knowledge in advanced crop improvement strategies.							
4. Evaluate chromosomal variations' evolutionary significance in breeding.							
5. Utilize chromosome mapping for practical genome applications.							
6. Apply di-haploids, and double haploids for gene fixation in breeding programs.							
Theory							
Unit: I							
Cell cycle and architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; artificial chromosome construction and its uses; Special types of chromosomes. Variation in chromosome structure: Evolutionary significance; Introduction to techniques for karyotyping; Chromosome banding and painting - In situ hybridization and various applications.							
Unit: II							
Structural and numerical variations of chromosomes and their implications; Symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids; Utilization of aneuploids in gene location; Variation in chromosome behaviour, somatic segregation and chimeras, endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal and chromosome complexes; Inter-varietal chromosome substitutions.							
Unit: III							
Fertilization barriers in crop plants at pre-and postfertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy. Genetic consequences of polyploidization and role of polyploids in crop breeding; Evolutionary advantages of autopolyploid vs allopolyploids; Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer; Alien addition and substitution lines, creation and utilization; Apomixis, evolutionary and genetic problems in crops with apomixes.							
Unit: IV							
Reversion of autopolyploid to diploids; Genome mapping in polyploids; Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, Triticale, Brassica, and cotton); Hybrids between species with same chromosome number, alien translocations; Hybrids between species with different chromosome number; Gene transfer using amphidiploids, bridge species.							
Unit: V							
Chromosome manipulations in wide hybridization; case studies; Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.							

Practical	
Learning the cytogenetical laboratory techniques, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning, etc.; Microscopy: various types of microscopes; Preparing specimen for observation; Fixative preparation and fixing specimen for light microscopy studies in cereals; Studies on mitosis and meiosis in crop plants; Using micrometres and studying the pollen grain size in various crops. Pollen germination in vivo and in-vitro; Demonstration of polyploidy.	
References	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Principles of Plant Breeding	L	T	P	C
24AG3027		2	0	1	3
Course Objectives:					
Enable the students to					
1. Comprehend the concepts of breeding methods and techniques to develop varieties					
2. Perceive the theoretical knowledge and practical skills to improve genetic gain					
3. Know the modern and advanced insights in plant breeding					
Course Outcomes:					
The students will be able to					
1. Understand the importance of plant breeding to develop new varieties by utilizing appropriate breeding methods and techniques					
2. Adopt the appropriate method of hybridization programs to improve the genetic gain of the crop					
3. Identify and evaluate the best combiners for variety and hybrid development					
4. Attain skills in maintenance breeding materials and varietal release procedures					
5. Apply special breeding techniques to develop pre-breeding material for genetic enhancement					
6. Acquire knowledge of participatory plant breeding and plant variety protection					
Theory					
Unit: I					
Early Plant Breeding; Accomplishments through plant breeding; Objectives of plant breeding; Patterns of Evolution in Crop Plants: Centre of Origin, Agro-biodiversity and its significance. Pre-breeding and plant introduction and role of plant genetic resources in plant breeding.					
Unit: II					
Genetic basis of breeding; self and cross pollinated crops including mating systems and response to selection; Nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding.					

Unit: III	
Pure line theory, pure line and mass selection methods; pedigree, bulk, backcross, single seed descent and multiline breeding; Population breeding in self-pollinated crops with special reference to diallel selective mating; Transgressive breeding.	
Unit: IV	
Breeding methods in cross-pollinated crops; Population breeding: mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/ inbreds. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.	
Unit: V	
Breeding methods in asexually/ clonally propagated crops, clonal selection. Special breeding techniques: Mutation breeding, Breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy. Cultivar development: testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers' rights.	
Practical	
Floral biology in self and cross-pollinated species; Selfing and crossing techniques; Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male sterility in field crops; Prediction of performance of double cross hybrid.	
References	
1. Allard RW. 1981. <i>Principles of Plant Breeding</i>. John Wiley & Sons. 2. Chahal GS and Gossal, SS. 2002. <i>Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches</i>. Narosa Publishing House. 3. Chopra VL. 2004. <i>Plant Breeding</i>. Oxford & IBH. 4. George A. 2012. <i>Principles of Plant Genetics and Breeding</i>. John Wiley & Sons. 5. Gupta SK. 2005. <i>Practical Plant Breeding</i>. Agribios. 6. Jain HK and Kharakwal MC. 2004. <i>Plant Breeding and–Mendelian to Molecular Approach</i>, Narosa Publications, New Delhi 7. Roy D. 2003. <i>Plant Breeding, Analysis and Exploitation of Variation</i>. Narosa Publ. House. 8. Sharma JR. 2001. <i>Principles and Practice of Plant Breeding</i>. Tata McGraw-Hill. 9. Sharma JP. 2010. <i>Principles of Vegetable Breeding</i>. Kalyani Publ, New Delhi. 10. Simmonds NW.1990. <i>Principles of Crop Improvement</i>. English Language Book Society. 11. Singh BD. 2006. <i>Plant Breeding</i>. Kalyani Publishers, New Delhi. 12. Singh S and Pawar IS. 2006. <i>Genetic Bases and Methods of Plant Breeding</i>. CBS.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Fundamentals of Quantitative Genetics	L	T	P	C
24AG3028		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on theoretical and computational skills for estimating the components of variation.					
2. Understand the mating designs and biometrical analysis in plant breeding.					
3. Interpret the results for gene action, scales and gene effects.					
Course Outcomes:					
The students will be able to					
1. Analyse the interactions and variations in gene for polygenic and oligogenic traits.					
2. Apply the gene actions and biometrical approaches for identifying suitable genotypes.					
3. Evaluate the designs of experiments and compute selection indices for trait specific programs.					

4. Examine the results of mating designs and their implications on gene actions. 5. Design mapping populations for QTL analysis and marker assisted breeding. 6. Elucidate the effect of G x E interactions and stability models in crop improvement	
Theory	
Unit: I	
Introduction and historical background of quantitative genetics, Multiple factor hypothesis, Qualitative and quantitative characters, Analysis of continuous variation mean, range, SD, CV; Components of variation- Phenotypic, Genotypic, Nature of gene action- additive, dominance and epistatic, linkage effect. Principles of analysis of variance and linear model, Expected variance components, Random and fixed effect model, Comparison of means and variances for significance.	
Unit: II	
Designs for plant breeding experiments- principles and applications; Variability parameters, concept of selection, simultaneous selection modes and selection of parents, MANOVA.	
Unit: III	
Association analysis- Genotypic and phenotypic correlation, Path analysis Discriminate function and principal component analysis, Genetic divergence analysis- Metroglyph and D ² , Generation mean analysis, Parent progeny regression analysis	
Unit: IV	
Mating designs- classification, Diallel, partial diallel, L × T, NCDs, and TTC; Concept of combining ability and gene action, G × E interaction-Adaptability and stability; Methods and models for stability analysis; Basic models- principles and interpretation, Bi-plot analysis.	
Unit: V	
QTL mapping, Strategies for QTL mapping- Desired population and statistical methods, QTL mapping in genetic analysis; Markers, Marker assisted selection and factors influencing the MAS, Simultaneous selection based on marker and phenotype.	
Practical	
Analysis and interpretation of variability parameters; Analysis and interpretation of Index score and Metroglyph; Clustering and interpretation of D ² analysis; Genotypic and phenotypic correlation analysis and interpretation; Path coefficient analysis and interpretation, Estimation of different types of heterosis, inbreeding depression and interpretation; A, B and C Scaling test; L × T analysis and interpretation, QTL analysis; Use of computer packages; Diallel analysis; G × E interaction and stability analysis.	
References	
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Course Code	Molecular Breeding and Bioinformatics	L	T	P	C
24AG3029		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the basic principles of molecular breeding and its advanced tools. 2. Gain knowledge and skills to exploit the usefulness of biotechnological tools for crop improvement. 3. Comprehend the practical applications of omics and transgenic techniques in crop improvement.					
Course Outcomes:					
The students will be able to 1. Practice micropropagation methods in various crop plants. 2. Demonstrate the quantification and quality assessment of plant genomic DNA. 3. Acquire skills in application of molecular markers in breeding programs. 4. Apply methods on gene mapping and tagging of agronomically important traits. 5. Adopt advanced techniques in transferring foreign genes into plants through rapid introgression methods. 6. Conceptualize legal and ethical views about GMOs.					
Theory					
Unit: I					
Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.					
Unit: II					
Allele mining; Marker assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.					
Unit: III					
Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.					
Unit: IV					
Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc and commercial releases; Biotechnology applications in male sterility/ hybrid breeding, molecular farming; Application of Tissue culture in molecular breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.					
Practical					
Requirements for plant tissue culture laboratory; Techniques in plant tissue culture; Media components and media preparation; Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretations; Inoculation of explants, callus induction and plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures; Plant Sciences–Genetics and Plant Breeding; Visit to commercial micropropagation unit; Transformation using Agrobacterium strains; GUS assay in transformed cells/ tissues; DNA isolation, DNA purity and quantification tests; Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship; Construction of genetic linkage maps using computer software; NCBI Genomic Resources, GBFF, Swiss Prot, Blast n/ Blast p, Gene Prediction Tool, Expaty Resources, PUBMED and PMC, OMIM and OMIA,					

ORF finder; Comparative Genomic Resources: Map Viewer (UCSC Browser and Ensembl);Primer designing- Primer 3/ Primer BLAST.

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Course Code	Hybrid Breeding	L	T	P	C
24AG3030		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the basic concepts of hybrid varieties 2. Realize the various techniques for development of hybrids in crop plants 3. Gain knowledge of various kinds of male sterility and their utilization in hybrid seed production of important field crops.					
Course Outcomes:					
The students will be able to 1. Examine the genetic mechanisms of heterosis 2. Explore the evolutionary aspects of crops 3. Analyze the various theories of heterosis. 4. Differentiate the types of hybrid seed production systems 5. Utilize genetic stocks in hybrid development 6. Exploit heterosis for yield improvement through conventional and biotechnological approaches.					
Theory					
Unit: I					
Historical aspect of heterosis, nomenclature and definitions of heterosis, Heterosis in natural population and inbred population, Evolutionary aspects – Genetic consequences of selfing, sibbing and crossing in self-and cross-pollinated and asexually propagated crops, Pre-Mendelian and Post-Mendelian ideas – Evolutionary concepts of heterosis, Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis, theories and their estimation, Biometrical basis of heterosis.					
Unit: II					
Prediction of heterosis from various crosses, inbreeding depression, coefficient of inbreeding and its estimation, residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies., Relationship between genetic distance and expression of heterosis, case studies, Divergence and genetic distance analyses, morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/ genetic stocks and inbreeds, their improvement for increasing heterosis.					

Unit: III	
Male sterility and use in heterosis breeding, Male sterile line creation and diversification in self-pollinated, cross pollinated and asexually propagated crops, Creation of male sterility through genetic engineering and its exploitation in heterosis, Maintenance, transfer and restoration of different types of male sterility, Use of self-incompatibility in development of hybrids.	
Unit: IV	
Hybrid seed production system: 3-line, 2-line and 1-line system, Development of inbreds and parental lines- A, B and R lines – functional male sterility, Commercial exploitation of heterosis, maintenance breeding of parental lines in hybrids, Fixation of heterosis in self, cross and often cross-pollinated crops, asexually/ clonally propagated crops, problems and prospects, Apomixis in fixing heterosis-concept of single line hybrid, Organellar heterosis and complementation.	
Unit: V	
Hybrid breeding in wheat, rice, cotton, maize, pearl millet, sorghum and rapeseed mustard, sunflower, safflower and castor oilseed crops and pigeonpea.	
Practical	
Characterization of male sterile lines using morphological descriptors, Restorer line identification and diversification of male sterile sources, Male sterile line creation in crop plants, problems in creation of CGMS system, ways of overcoming them, Diversification and restoration, Success stories of hybrid breeding in Maize, Rice, Pearl millet, Sorghum and Pigeon pea, Understanding the difficulties in breeding apomicts, Estimation of heterotic parameters in self, cross and asexually propagated crops, Estimation from the various models for heterosis parameters, Hybrid seed production in field crops—an account on the released hybrids, their potential, problems and ways of overcoming it, Hybrid breeding at National and International level, opportunities ahead.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Breeding For Quality and Special Traits	L	T	P	C
24AG3031		2	0	1	3
Course Objectives:					
Enable the students to					
1. Know the inheritance pattern of quality traits.					
2. Understand the molecular basis of quality traits in different crop species.					
3. Gain knowledge on the concept of Nutrigenomics.					
Course Outcomes:					
The students will be able to					

1. Acquire an insight in recent advances in improvement of quality traits. 2. Assess the breeding methods to increase the physiological efficiency of crops. 3. Apply their knowledge on developmental biochemistry of carbohydrate and Proteins. 4. Develop GMOs with improved quality. 5. Recognize the genetic engineering tools for quality improvement. 6. Evaluate the mapping populations using MAS procedures.	
Theory	
Unit: I	
Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors; Nutritional improvement - A human perspective.	
Unit: II	
Breeding for grain quality parameters in rice and its analysis; Golden rice and aromatic rice: Breeding strategies, achievements and application in Indian context; Molecular basis of quality traits and their manipulation in rice; Post harvest manipulation for quality improvement; Breeding for baking qualities in wheat, characters to be considered and breeding strategies, molecular and cytogenetic manipulation for quality improvement in wheat.	
Unit: III	
Breeding for quality improvement in Sorghum, pearl millet, barley and oats; Quality protein maize, specialty corns, concept and breeding strategies; Breeding for quality improvement in important forage crops for stay green traits; Genetic resource management for sustaining nutritive quality in crops.	
Unit: IV	
Breeding for quality improvement in pulses – Chickpea, pigeonpea, green gram and black gram cooking quality; Breeding for quality in oilseeds -groundnut, mustard, soybean, sesame, sunflower and minor oilseeds; Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton. Breeding for quality improvement in Sugarcane, and potato.	
Unit: V	
Genetic engineering protocols for quality improvement: Achievements made; Biofortification in crops; Classification and importance, Nutritional genomics and Second generation transgenics.	
Practical	
Grain quality evaluation in rice; Correlating ageing and quality improvement in rice; Quality analysis in millets; Estimation of anti-nutritional factors like tannins in different varieties/ hybrids: A comparison; Quality parameters evaluation in wheat, pulses and oilseeds; Evaluation of quality parameters in cotton, sugarcane and potato; Value addition in crop plants; Post-harvest processing of major field crops; Quality improvement in crops through tissue culture techniques; Evaluating the available populations like RIL, NIL, etc. for quality improvement using MAS procedures; Successful example of application of MAS for quality trait in rice, mustard, maize, etc.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Mutagenesis and Mutation Breeding	L	T	P	C

24AG3032	2	0	1	3
Course Objectives:				
Enable the students to 1. Gain knowledge on the types of mutations and the impact of developing new cultivars in crop plants. 2. Apply various methods for handling the large mutant population and selection procedures to identify the elite mutants in crop species. 3. Comprehend the risks and perspectives associated with the effects of mutagens				
Course Outcomes:				
The students will be able to 1. Estimate the dose concentration for acquiring the desired mutants. 2. Evaluate the effect of mutations on improving qualitative and quantitative traits. 3. Adopt various methods of mutations inducing variations in crop plants. 4. Investigate the segregating mutant population in various crop plants to identify the elite mutant segregants. 5. Implement various selection procedures for trait improvement and trait mapping. 6. Apply the advanced mutational breeding approaches involving TILLING, allele mining and genomics.				
Theory				
Unit: I				
Mutation and its history, nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post-adaptive mutations; Detection of mutations. Paramutations in crops plants.				
Unit: II				
Mutagenic agents: physical – -radiation types and sources: Ionizing and non-ionizing radiations. Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships; Effect of mutations on DNA – repair mechanisms operating at DNA, chromosome, cell and organism levels to counteract the mutation effects; Dosimetry -Objects and methods of treatment; Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects; Radiation sensitivity and modifying factors: External and internal sources – Oxygen, water content, temperature and nuclear volume.				
Unit: III				
Chemical mutagens: Classification – base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action; Dose determination and factors influencing chemical mutagenesis; Treatment methods using physical and chemical mutagens, Combination treatments; other causes of mutation – direct and indirect action, comparative evaluation of physical and chemical mutagens.				
Unit: IV				
Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras, etc.; Observing mutagen effects in M2 generation; Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations; Mutations in traits with continuous variation; Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage, etc.; Individual plant-based mutation analysis and working out effectiveness and efficiency in M3 generation; Comparative evaluation of physical and chemical mutagens for creation of variability in some species- Case studies.				
Unit: V				
Use of mutagens in creating oligogenic and polygenic variations – Case studies; In-vitro mutagenesis – Callus and pollen irradiation; Handling of segregating M2 generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc.) in different crops; Procedures for micro mutations breeding/ polygenic mutations; Achievements of mutation breeding- varieties released across the world, problems associated with mutation breeding. Use of mutagens in genomics, allele mining, TILLING.				
Practical				
Precautions on handling of mutagens; Dosimetry-Studies of different mutagenic agents: Physical mutagens and Chemical mutagens; Learning on Radioactivity- Production source and isotopes at BRIT, Trombay, Learning about gamma chamber; Radiation hazards: Monitoring – safety regulations and safe				

transportation of radioisotopes, visit to radioisotope laboratory; learning on safe disposal of radioisotopes; Hazards due to chemical mutagens – Treating the plant propagules at different doses of physical and chemical mutagens; Procedures in combined mutagenic treatments; Raising the crop for observation; Mutagenic effectiveness and efficiency, calculating the same from earlier literature; Study of M1 generation – Parameters; Study of M2 generation – Parameters; Mutation breeding in cereals and pulses-achievements made and an analysis; Mutation breeding in oilseeds and cotton- achievements and opportunities; Mutation breeding in forage crops and vegetatively propagated crops; Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

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Course Code	Breeding for Stress Resistance and Climate Change	L	T	P	C
24AG3033		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on special breeding methods for stress resistance					
2. Comprehend the mechanism of biotic and abiotic stress tolerance in crop plants					
3. Understand the protocols for the development of stress-tolerant hybrids in varieties in various crop species					
Course Outcomes:					
The students will be able to					
1. Acquire skills in the development of breeding populations to identify elite stress-tolerant genotypes					
2. Apply different breeding protocols to develop durable stress-tolerant varieties in plants					
3. Evaluate the breeding materials for different types of biotic and abiotic stresses using standard screening protocols					
4. Acquire skills in gene pyramiding and stacking techniques to enhance the stress resistance potential of the crop					
5. Adopt marker-assisted selection to identify pyramided genotypes for stress tolerance					
6. Apply genomic approaches to develop climate-resilient crop varieties					
Theory					
Unit: I					
Concept and impact of climatic change; Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops.					
Unit: II					
Concepts of resistance to insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defence mechanisms against viruses and bacteria.					
Unit: III					

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants; Quantitative resistance/ adult plant resistance and slow rusting resistance; Classical and molecular breeding methods – Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies; Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence; Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc.; Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

Unit: IV

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton, etc.; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/ contaminants in soil, water and environment.

Unit: V

Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops; Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management.

Practical

Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures; Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level; Phenotypic screening techniques for nematodes and borers; Ways of combating them; Evaluating the available populations like RIL, NIL, etc. for pest resistance; Use of standard MAS procedures. Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance; Screening crops for drought and flood resistance; factors to be considered and breeding strategies; Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation.

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Course Code	Varietal Development and Maintenance Breeding	L	T	P	C
24AG3034		1	0	1	2

Course Objectives:

Enable the students to

1. Understand the varietal development systems and variety release norms

2. Acquire skill in maintenance breeding	
3. Gain knowledge on seed production technology	
Course Outcomes:	
The student will be able to	
1.Explain the various seed production systems	
2.Recognise the utilisation of DUS descriptors	
3.Relate the factors responsible for genetic deterioration of varieties	
4.Examine the various generation systems of seed multiplication	
5.Develop methods for quality seed production	
6.Apply the seed certification procedures for quality seed production	
Theory	
Unit: I	
Variety Development systems and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, landraces, hybrid, and population; Variety testing, release and notification systems and norms in India and abroad.	
Unit: II	
DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties - safeguards during seed production.	
Unit: III	
Maintenance of varieties in self- and cross-pollinated crops, isolation distance; Principles of seed production; Methods of nucleus and breeder seed production; Generation system of seed multiplication - nucleus, breeders, foundation, certified.	
Unit: IV	
Quality seed production technology of self and cross-pollinated crop varieties, viz., cereals and millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi, etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton/ jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).	
Unit: V	
Seed certification procedures; Seed laws and acts, plant variety protection regulations in India and international systems.	
Practical	
Identification of suitable areas/ locations for seed production; Ear-to-row method and nucleus seed production; Main characteristics of released and notified varieties, hybrids and parental lines; PGMS and TGMS; Identification of important weeds/ objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops; DUS testing and descriptors in major crops; Variety release proposal formats in different crops.	
References	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Seed Production and Certification	L	T	P	C
24AG3035		1	0	1	2
Course Objectives:					
Enable the students to					
1.Gain knowledge on the various concepts of seed quality					
2.Interpret the principles of seed production					

3. Analyse the various seed certification systems
Course Outcomes:
The students will be able to 1. Infer the various factors responsible for varietal deterioration 2. Explain the various seed certification standards of various crops 3. Examine the pollination mechanisms and floral biology 4. Analyse the seed certification procedures for various crops 5. Implement hybrid seed production technology systems and techniques 6. Apply the various procedures for seed certification
Theory
Unit: I
Importance of seed as basic input in agriculture; Seed quality concept and importance; Generation system of seed multiplication -Varietal replacement rate, Seed multiplication ratios, Seed replacement rate, Seed renewal period and seed demand and supply; Various factors influencing seed production –Physical and Genetic purity in seed production; Factors responsible for varietal and genetic deterioration.
Unit: II
Nucleus seed production and its maintenance - Maintenance of parental lines of hybrids, Production of breeder, foundation and certified seed and their quality maintenance; Principles of seed production in self- and cross-pollinated crops; Hybrid seed production - system and techniques involved in Seed village concept; Organic seed production and certification.
Unit: III
Principles of seed production in field crops; Floral structure, pollination mechanism and seed production techniques in self- and cross-pollinated cereals and millets.
Unit: IV
Floral structure, pollination mechanism and methods and techniques of seed production in major pulses and oilseed crops; Varietal and hybrid seed production techniques in Pigeon pea, Mustard, Castor and Sunflower.
Unit: V
Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres. Hybrid-seed production techniques in major vegetatively propagated crops.
Unit: VI
Seed certification - history, concept, objectives; Central seed certification board Seed certification agency/ organization and staff requirement; Legal status - Phases of seed certification, formulation, revision and publication of seed certification standards; Minimum Seed Certification Standards (MSCS) for different crops - General and specific crop standards, Field and seed standards; Planning and management of seed certification programs; Eligibility of a variety for certification, area assessment, cropping history of the seed field.
Practical
Planting design for variety- hybrid seed production techniques, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; Identification of rogues and pollen shedders, supplementary pollination, detasseling, hand emasculation and pollination; Pollen collection and storage methods, pollen viability and stigma receptivity; Pre-harvest sanitation, maturity symptoms, harvesting techniques; Visits to seed production plots - visit to seed industries; Planning for seed production: cost benefit ratio, seed multiplication ratio and seed replacement rate; General procedure of seed certification, identification of weed and other crop seeds as per specific crops, field inspection at different stages of a crop and observations recorded on contaminants and reporting of results, inspection and sampling, harvesting/ threshing, processing and after processing for seed law enforcement; Specifications for tags and labels to be used for certification purpose.
References
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Crop Breeding-I (Kharif Crops)	L	T	P	C
24AG3037		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on the evolution pattern and modes of reproduction of various kharif crop species					
2. Acquire skills in conventional breeding methods and strategies in the development of new crop cultivars					
3. Comprehend the usage of advanced breeding methods in crop improvement					
Course Outcomes:					
The students will be able to					
1. Identify the modes of reproduction of crops species of kharif crops based on floral biology					
2. Utilize crop varieties for hybrid development and trait improvement in kharif crops					
3. Evaluate the breeding population to develop new varieties in kharif crops					
4. Implement various selection procedures to enhance the genetic gain of the beneficial traits in kharif crops					
5. Adopt various advanced protocols for new variety development in kharif crops					
6. Apply advanced breeding schemes to improve the genetic makeup of the in kharif crops					
Theory					
Unit: I					
Rice: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding.					
Maize: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement- QPM and Bt maize – strategies and implications.					
Small millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc.					
Unit: II					

Pigeon pea: evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes.

Groundnut: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Other pulses: Urdbean, mungbean, cowpea: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

Unit: III

Soybean: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Castor and Sesame: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement; Hybrid breeding in castor – opportunities, constraints and achievements.

Unit: IV

Cotton: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton.

Jute: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Unit: V

Sugarcane: Evolution and distribution of species and forms, wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc.

Forage crops: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance, etc.

Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement; Achievements of important spice crops.

Practical

Floral biology, emasculation, pollination techniques in rice, maize, pigeon pea, soybean, sesame, cotton; Study of range of variation for yield and yield components; Study of segregating populations in cereal, pulses and oilseed crops; Learning on the crosses between different species; attempting crosses between black gram and green gram; Evaluating the germplasm of cotton for yield, quality and resistance parameters, learning the procedures on development of Bt cotton; Visit to Cotton Technology Laboratory and Spinning Mills; Learning on the Standard Evaluation System (SES) and descriptors; Use of software for database management and retrieval; Practical learning on the cultivation of fodder crop species on

sewage water, analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories; Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

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Course Code	Crop Breeding-II (Rabi Crops)	L	T	P	C
24AG3038		2	0	1	3
Course Objectives:					
Enable the students to					
1. Acquire knowledge on the evolution pattern and modes of reproduction of various rabi crop species					
2. Attain skills in conventionasl breeding methods and population development in rabi crops					
3. Realize the use of advanced breeding methods in crop improvement					
Course Outcomes:					
The students will be able to					
1. Categorize the modes of reproduction of crops species of rabi crops based on floral biology					
2. Exploit crop varieties for hybrid development and trait improvement in rabi crops					
3. Assess the breeding population to develop new varieties in rabi crops					
4. Adopt various selection procedures to enhance the genetic gain of the beneficial traits in rabi crops					
5. Implement various advanced protocols for new variety development in rabi crops					
6. Evaluate advanced breeding schemes to improve the genetic makeup of the in rabi crops					
Theory					

Unit: I Wheat: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Oats: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Barley: Origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.
Unit: II Chickpea: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Other pulses: Lentil, field pea, Rajma, Horse gram: Origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.
Unit: III Rapeseed and Mustard: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives; yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Oil quality, Improvement for oil quality. Sunflower, Safflower: Origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.
Unit: IV Mesta and minor fibre crops: Origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Forage crops: Origin, evolution mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance.
Unit: V Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, scope of heterosis breeding, released varieties, examples of MAS used for crop improvement.
Practical Floral biology, emasculation and pollination techniques in wheat, oats, barley, chickpea, rajma, rapeseed mustard, sunflower; Study of range of variation for yield and yield components; Study of segregating populations in cereal, pulses and oilseed crops; Use of descriptors for cataloguing; Learning on the crosses between different species; Trait based screening for stress resistance; Learning on the Standard Evaluation System (SES) and descriptors; Use of software for database management and retrieval.
References 1. Agarwal RL. 1996. <i>Identifying Characteristics of Crop Varieties</i> . Oxford & IBH.

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Recommended by the Board of Studies	02.02.2024
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Course Code	Breeding Vegetable Crops	L	T	P	C
24AG3039		2	0	1	3
Course Objectives:					
Enable the students to					
1. Acquire knowledge on breeding for Vegetables and Leafy vegetables					
2. Perceive the hybridization methods in Vegetables					
3. Utilize the conventional and advanced prospects of varietal development					
Course Outcomes:					
The students will be able to					
4. Comprehend the concepts of selection and hybridization in vegetables					
5. Analyze the role of quantitative and qualitative traits in breeding					
6. Evaluate the methods for inducing flowering and handling segregating populations					
7. Implement hybrid seed production technology in vegetables					
8. Incorporate molecular markers and biotechnological tools in identifying desirable genotypes					
9. Select the stress tolerant genotypes under appropriate screening techniques for abiotic and biotic stress					
Theory					
Unit: I					
Breeding for Leafy vegetables: Amaranth, chenopods and lettuce.					
Unit: II					
Breeding for Cucurbits: Gourds, melons, pumpkins and squashes.					
Unit: III					
Breeding for Solanaceae: Potato and tomato, eggplant, hot pepper, sweet pepper					
Unit: IV					
Breeding for Cole crops: Cabbage, cauliflower, broccoli and knolkhol. Breeding for Root vegetables: Carrot, beetroot, radish, sweet potato and tapioca.					
Unit: V					
Breeding for other vegetable crops: Peas, beans, onion, garlic and okra.					
Practical					
Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm; Hybridization and handling segregating generations; Induction of flowering, palanological studies, selfing and crossing techniques in vegetable crops; Hybrid seed production of vegetable crops in bulk; Screening techniques for insect-pests, disease and environmental stress resistance in vegetable crops; Demonstration of sib-mating and mixed population; Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques; Visit to breeding blocks, MAS for incorporating traits governed by major and polygenes.					
References					
1. Allard RW. 1999. <i>Principles of Plant Breeding</i> . John Wiley & Sons.					
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6. Rai N and Rai M. 2006. <i>Heterosis Breeding in Vegetable Crops</i> . New India Publication Agency.					

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Recommended by the Board of Studies	02.02.2024
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Course Code	Breeding Fruit Crops	L	T	P	C
24AG3040		2	0	1	3
Course Objectives:					
Enable the students to					
1. Review the historical concepts and importance of fruit breeding					
2. Gain knowledge on the prospects and techniques of fruit breeding					
3. Perpetuate the techniques of apomixis, genetic engineering and biotechnology for fruit improvement					
Course Outcomes:					
The students will be able to					
1. Comprehend the centers of origin of fruits, distribution and domestication					
2. Analyze the factors and issues involved in fruit crop breeding					
3. Evaluating the importance of incompatibility and sterility systems					
4. Examine the applications of apomixis, parthenocary and polemebryony in fruits					
5. Apply the genetic engineering techniques for introgression for desirable traits					
6. Explore the practices of mutation and polyploidy breeding in fruits					
Theory					
Unit: I					
Fruit crop breeding: History, importance of fruit breeding, centers of diversity, distribution, domestication and adaptation of commercially important fruits.					
Unit: II					
Issues in fruit crop breeding – heterozygosity, polyploidy, polyembryony, parthenocary and seed lessness, incompatibility and sterility systems.					
Unit: III					
Apomixis - merits and demerits, types, variability for economic traits, role of genetic engineering and biotechnology in improvement of fruit crops.					
Unit: IV					
Crop improvement in Mango, Banana, Citrus, Grapes, Papaya, Sapota and Pomegranate, Pineapple and Guava, Apple and other Rosaceous crops and region-specific fruit crops.					
Practical					
Germplasm documentation; Floral biology of mango, guava, citrus, grape, pomegranate, pollen viability in major fruit crops; Pollen germination to study time of anthesis and stigma receptivity; Hybridization technique in important fruit crops, hybrid seed collection and raising; Colchicine treatment for induction of polyploidy; Exposure to resistance breeding and screening techniques; Mutation breeding practices raising and evaluation of segregating populations; Use of mutagens to induce mutations and polyploidy; Visit to Biotechnology Lab and study of <i>in-vitro</i> breeding techniques.					
References					
1. Bhojwani SS and Razdan MK. 2006. <i>Plant Tissue Culture -Theory and Practice</i> . Elsevier Publication, Amesterdam.					
2. Chadha KL and Pareek, OP. 1996. (Eds.). <i>Advances in Horticulture</i> . Vol. I to IV. Malhotra Publ. House, New Delhi.					
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Recommended by the Board of Studies	02.02.2024
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Course Code	Breeding Ornamental Crops	L	T	P	C
24AG3041		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on the history and objectives of Ornamental breeding					
2. Perceive the different breeding methods for handling Ornamental crops					
3. Utilize the hybridization techniques for developing elite ornamental varieties					
Course Outcomes:					
The students will be able to					
1. Comprehend the concepts of centers of origin, diversity and domestication of ornamental crops					
2. Analyze the breeding strategies and objectives of various ornamental crops					
3. Examine the role of heterosis and hybridization techniques in ornamental plants					
4. Implement male sterility and incomptability for producing F ₁ hybrids					
5. Evaluate the production of open pollinate seeds, harvest, processing and storage of ornamental seeds					
6. Adopt the standard seed certification procedures for ornamental seed production					
Theory					
Unit: I					
History of improvement of ornamental plants; Centre of origin of ornamental crop; Objectives and techniques in ornamental plant breeding.					
Unit: II					
Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops, viz., Rose, Jasmine, <i>Chrysanthemum</i> , Tuberose, <i>Gerbera</i> , <i>Gladiolus</i> , <i>Dahlia</i> , <i>Lilium</i> , <i>Gaillardia</i> , <i>Petunia</i> , <i>Bougainvillea</i> , Pansy, Marigold, <i>Geranium</i> , <i>Antirrhinum</i> , China aster, Orchids, <i>Carnation</i> , <i>Hibiscus</i> , etc.					
Unit: III					
Development of promising cultivars of important ornamental and flower crops; Role of Heterosis and its exploitation, production of F1 hybrids and utilization of male sterility.					
Unit: IV					
Production of open pollinated seeds, harvesting, processing and storage of seeds; Seed certification.					
Practical					
Study of floral biology and pollination in important species and cultivars of ornamental crops; Techniques of inducing polyploidy and mutation; Production of pure and hybrid seed; Methods of breeding suited to seed propagated plants; Polyploidy and mutations to evolve new varieties; Breeding methods for biotic and abiotic stresses; Visit to research institutes involved in ornamental crop breeding.					
References					
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Recommended by the Board of Studies		02.02.2024			

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24.02.2024

Course Code	Germplasm Characterization and Evaluation	L	T	P	C
24AG3042		1	0	1	2
Course Objectives:					
Enable the students to 1. Review the genetic diversity and crop descriptors 2. Gain knowledge on characterization and evaluation through agro-morphological data 3. Acquaint techniques of germplasm maintenance and regeneration					
Course Outcomes:					
The students will be able to 1. Comprehend the concepts of genetic diversity and activities in plant genetic resources 2. Analyze the data through statistical and web-based tools for population maintenance 3. Evaluate the different modes of conservation, regeneration and maintenance of germplasm 4. Identify the suitable crop wild relatives for utilization as donors in breeding programs 5. Adopt phenomics and genomic tools for high throughput germplasm characterization 6. Apply the biochemical and molecular markers for marker-trait association studies					
Theory					
Unit: I Understanding genetic diversity in crop plants; Crop descriptors, descriptor states; germplasm characterization/ evaluation procedures; evaluation of germplasm for specific traits; Measuring diversity using agro-morphological data, statistical procedures to measure population genetic variation, markers and their use in PGR, evaluation of biotic and abiotic stresses, Principles and methods for formulating core and mini core collections and their validation, Web based tools for management of data.					
Unit: II Principles and practices of germplasm regeneration and maintenance, breeding systems and mode of reproduction; maintaining sufficiently large populations for effective conservation of farmer landraces, evaluation and maintenance of wild relatives of crop plants. Genetic enhancement, Use of CWRs genetic resources for crop improvement.					
Unit: III High throughput phenotyping systems- imaging and image processing concepts for automated germplasm characterization (phenotyping) – evaluation for nutritional traits, resistance traits -Biochemical and molecular markers for characterization.					
Practical Field layout and experimental designs; Recording field data on germplasm evaluation in different agri-horticultural crops, post harvest handling; Evaluating quality traits, biochemical and phyto-chemical evaluation of crop germplasm, data processing; Documentation, analysis of diversity and cataloguing, data analysis, viability equations, sampling strategies, data documentation, cataloguing, biochemical analyses of samples.					
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Genetic Enhancement for PGR Utilization	L	T	P	C
24AG3043		1	0	1	2
Course Objectives:					
Enable the students to					
1. Gain knowledge on Pre-Breeding and CWR					
2.Review the methods involved in overcoming crossing barriers					
3.Explore and utilize the activies involved in plant genetic resource conservation					
Course Outcomes:					
The students will be able to					
1.Comprehend the concepts of gene pool and CWR					
2.Analyze the maintenance and adaptation of germplasm aceesions					
3.Examine the screening techniques for biotic and abiotic resistance					
4.Identify desirable traits through genetic analysis of novel traits					
5.Integrate the cytological and polyploidy breeding for the management of incongruity					
6.Assess the pre and post zygotic barriers in wide cross and derivatives					
Theory					
Unit: I					
Concepts of gene pools; Introduction, potential of pre-breeding. Role of crop wild relatives, semi exotics, creating and managing variation, basic concepts to set up a successful pre-breeding programme.					
Unit: II					
Understanding crop adaptation, handling and maintenance of CWRs, synchronization of flowering, overcoming impediments to flowering through photoperiodic adjustments, role of other barriers to flowering, role of amphidiploids, semi exotics and other unadapted germplasm, identifying desirable traits in natural populations, screening for biotic and abiotic stress resistance traits; screening of nutritionally important traits, genetic analysis to understand the inheritance of novel traits.					
Unit: III					
Parental selection for prebreeding, search for superior genotypes, breeding methods for trait transfer; moving the genes - unadapted to adapted, wide hybridization, Incongruity and its management, modern tools for incongruity management, cytogenetical approaches for gene transfer such as alien addition and substitution, segregating populations and their management in wide crosses, purging the undesirable traits, testing and improving the adaptability of wide cross derivatives, cytological studies, florescence microscopy, embryo rescue methods, pollen physiology and storage, pollen storage methods to facilitate wide hybridization, pre- and postzygotic barriers.					
Practical					
Characterization of CWRs by visiting the fields; Screening methods for special traits-biotic and abiotic resistance; Screening for nutritional traits; Crossability studies in CWRs of cereals, legumes, oilseeds, vegetables. Assessment of pre and post-zygotic barriers in wide hybridization crosses; Pollen storage studies; Special requirements for growing CWRs, inducing flowering by manipulating day length, temperature, chemical spraying, etc.					
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Recommended by the Board of Studies	02.02.2024
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Course Code	Tropical Fruit Production	L	T	P	C
24HO3127		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the cultural requirements of tropical fruit crops.					
2. Analyse the causes that limit the production and management of tropical fruit crops.					
3. Gain knowledge on the potential for industrial exploitation and export opportunities of tropical fruit crops.					
Course Outcomes:					
The students will be able to					
1. Undertake production of elite planting material of tropical fruit crops with rootstocks suited for specific situations.					
2. Upgrade the traditional orchards using the knowledge obtained.					
3. Improve the quality of the final produce with application of suitable strategies.					
4. Equip with technical know-how of packing, storage and ripening of tropical fruits.					
5. Establish and manage an orchard leading to optimum and quality tropical fruit production.					
6. Acquire skills on industrial value and export of fruits.					
Theory					
Block 1: Introduction					
Unit: I					
Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.					
Block 2: Agro-techniques					
Unit: I					
Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.					
Block 3: Crop management					
Unit: I					
Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by					

management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

Crops

Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.

Practical

Distinguished features of tropical fruit species, cultivars and rootstocks. Demonstration of planting systems, training and pruning. Hands on practices on pollination and crop regulation. Leaf sampling and nutrient analysis. Physiological disorders-malady diagnosis. Physico-chemical analysis of fruit quality attributes. Field/ Exposure visits to tropical orchards. Project preparation for establishing commercial orchards.

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Course Code	Sub-Tropical and Temperate Fruit Production	L	T	P	C
24HO3128		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the cultural requirements of subtropical and temperate fruit crops. 2. Analyse the factors that limit the production of subtropical and temperate fruit crops. 3. Gain knowledge on the potential for industrial exploitation and export opportunities of the crops.					
Course Outcomes:					
The students will be able to					
1. Get acquainted with ecological specifications, seasonal variations and pertinent cultural practices of subtropical and temperate fruits. 2. Undertake the production of elite planting material of major fruit crops with rootstocks suited for specific situations. 3. Undertake cultivation of subtropical and temperate fruit crops on scientific basis. 4. Maintain a subtropical and temperate fruit orchard by applying knowledge obtained. 5. Produce superior quality of subtropical and temperate fruits by applying specific strategies. 6. Apply modern methods of ripening, packaging and storing of subtropical and temperate fruits.					

Theory	
Block 1: Introduction	
Unit: I	
Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.	
Block 2: Agro-techniques	
Unit: I	
Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.	
Block 3: Crop management	
Unit: I	
Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.	
Crops	
Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.	
Practical	
Distinguished features of fruit species, cultivars and rootstocks. Demonstration of planting systems, training and pruning. Hands on practices on pollination and crop regulation. Leaf sampling and nutrient analysis. Physiological disorders-malady diagnosis. Physico-chemical analysis of fruit quality attributes. Field/ Exposure visits to subtropical and temperate orchards. Project preparation for establishing commercial orchards.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Propagation and Nursery Management in Fruit Crops	L	T	P	C
24HO3129		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the cellular basis of plant propagation. 2. Understand the principles of selection of mother plants for budding and grafting and issues related with. 3. Learn the principles, concepts and methods of <i>in vitro</i> propagation for various horticultural crops.					
Course Outcomes:					
The students will be able to 1. Apply the principles and methods of sexual and asexual propagation of fruit crops. 2. Analyze the factors affecting seed germination, dormancy and hormonal regulation of growth of fruit crops 3. Apply the principles and methods of budding and grafting of fruit crops 4. Establish a scientific scion bank of elite and commercial fruit crop varieties. 5. Set up a micropropagation/ tissue culture lab for commercial exploitation of fruit crops. 6. Adopt quarantine, nursery act, nursery accreditation, import and export of seeds and planting material for establishment of fruit crop nursery.					
Theory					
Block 1: Introduction					
Unit: I					
General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.					
Block 2: Propagation					
Unit: I					
Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods. Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship, – graft incompatibility, physiology of rootstock and top working.					
Unit: II					
Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – <i>in-vitro</i> clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.					
Block 3: Nursery					
Unit: I					
Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.					
Practical					
Hands on practices on rooting of dormant and summer cuttings. Anatomical studies in rooting of cutting and graft union. Hands on practices on various methods of budding and grafting. Propagation by layering and stooling. Micropropagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening. Visit to commercial tissue culture laboratories and accredited nurseries.					
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Breeding of Fruit Crops	L	T	P	C
24HO3130		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the taxonomy and cytogenetics of different fruit crops.					
2. Learn the breeding objectives, systems and approaches for different fruit crops.					
3. Gain knowledge on the achievements of breeding and future thrust in different fruit crops.					
Course Outcomes:					
The students will be able to					
1. Get acquainted with taxonomy and cytogenetics of fruit crops.					
2. Get acquainted with blossom biology and breeding systems of fruit crops.					
3. Develop potential hybrids using conventional and non-conventional breeding methods for development of fruit crops.					
4. Develop resistant varieties using local genetic resources for biotic and abiotic stresses.					
5. Apply biotechnological interventions for improvement of quality traits of fruit crops.					
6. Develop a breeding program for production of high yielding varieties and hybrids of fruit crops.					
Theory					
Block 1: Introduction					
Unit: I					
Importance, Taxonomy and Genetic Resources: Introduction and importance, origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources.					
Block 2: Reproductive Biology					
Unit: I					
Blossom Biology and Breeding Systems: blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes.					
Block 3: Breeding Approaches					
Unit: I					
Conventional and Non-Conventional Breeding: Approaches for cropimprovement – direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts.					
Crops					
Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya,Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts.					
Practical					

Exercises on bearing habit, floral biology. Pollen viability and fertility studies. Hands on practices in hybridization. Raising and handling of hybrid progenies. Induction of mutations and polyploidy. Evaluation of biometrical traits and quality traits. Screening for resistance against abiotic stresses. Developing breeding programme for specific traits. Visit to research stations working on fruit breeding

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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	24.02.2024

Course Code	Export Oriented Fruit Production	L	T	P	C
24HO3131		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on the export potential of various fruit crops.					
2. Gain knowledge on the policies and quality standards for export of fruit crops.					
3. Gain knowledge on quality fruit production under protected cultivation.					
Course Outcomes:					
The students will be able to					
1. Get acquainted with the national and international trade scenario of fruit crops.					
2. Apply the norms and standards to meet the export requirements of fruit crops.					
3. Apply necessary techniques required for quality fruit production.					
4. Set up the required infrastructure and facilities for fruit production under protected cultivation.					
5. Gain expertise in postharvest management and supply chain of horticultural produce for export.					
6. Get acquainted with phytosanitary requirements and application procedures for export of fruits.					
Theory					
Block 1: Introduction					
Unit: I					
Statistics and World Trade: National and international fruit export and import scenario and trends; Statistics and India's position and potentiality in world trade; export promotion zones in India. Government Policies.					
Block 2: Regulations					
Unit: I					
Policies, Norms and Standards: Scope, produce specifications, quality and safety standards for export of fruits, viz., mango, banana, grape, litchi, pomegranate, walnut, apple and other important fruits. Processed and value-added products, post harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; WTO and its implications, sanitary and phyto-sanitary measures.					
Block 3: Quality Assurance					
Unit: I					
Infrastructure and Plant Material: Quality fruit production under protected environment; different types of structures – Automated greenhouses, glasshouse, shade net, poly tunnels – Design and					

development of low cost greenhouse structures. Seed and planting material; meeting export standards, implications of plant variety protection – patent regimes.	
Practical	
Export promotion zones and export scenario of fresh fruits and their products. Practical exercises on quality standards of fruits for export purpose. Quality standards of planting material and seeds. Hi-tech nursery in fruits. Practicals on ISO specifications and HACCP for export of fruits. Sanitary and phyto-sanitary measures during export of horticultural produce. Post harvest management chain of horticultural produce for exports. Visit to export oriented units/ agencies like APEDA, NHB, etc.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Canopy Management of Fruit Crops	L	T	P	C
24HO3132		1	0	1	2
Course Objectives:					
Enable the students to					
1. Understand the essential of canopy management in fruit crops.					
2. Understand the various factors affecting canopy development in different fruit crops.					
3. Understand the techniques and methods of canopy management.					
Course Outcomes:					
The students will be able to					
1. Get acquainted with canopy types and structures of fruit crops and their management.					
2. Get acquainted with the factors affecting canopy management of fruit crops					
3. Apply the principles of canopy management of fruit crops for yield improvement.					
4. Exploit the dwarfing rootstocks in canopy management of fruit crops.					
5. Undertake canopy management of fruit crops by application of growth regulators.					
6. Design planting system for fruit crops based on the different canopy styles.					
Theory					
Block 1: Canopy Architecture					
Unit: I					
Introduction, Types and Classification: Canopy management – importance and factors affecting canopy development. Canopy typesand structures, canopy manipulation for optimum utilization of lightand its interception. Spacing and utilization of land area – Canopy classification.					
Block 2: Canopy Management					
Unit: I					
Physical Manipulation and Growth Regulation: Canopy management through rootstock and scion. Canopy management through plant growth regulators, training and pruning and management practices. Canopydevelopment and management in relation to growth, flowering, fruiting and fruit quality.					
Practical					
Study of different types of canopies.Training of plants for different canopy types. Canopy development through pruning. Understanding bearing behaviour and canopy management in different fruits. Use of plant growth regulators. Geometry of planting. Development of effective canopy with support system. Study on effect of different canopy types on production and quality of fruits.					
References					
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Recommended by the Board of Studies	02.02.2024
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Course Code	Growth and Development of Fruit Crops	L	T	P	C
24HO3133		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on the basic principles of growth and development in fruit crops.					
2. Understand and exploit use of growth regulators and inhibitors in fruit crops.					
3. Understand and manage the various stresses in the growth and development of fruit crops.					
Course Outcomes:					
The students will be able to					
1. Define the fundamental concepts of growth and development physiology of fruit crops.					
2. Analyze the effect of environmental factors in the growth and development of fruit crops					
3. Analyze the effect of water and mineral nutrition in the growth and development of fruit crops.					
4. Evaluate and remediate the various biochemical and physiological processes in the growth and development of fruit crops.					
5. Adopt strategies for stress management in the growth and development processes of fruit crops.					
6. Apply suitable PGRs for manipulation of the growth and development of fruit crops.					
Theory					
Block 1: Introduction					
Unit: I					
General Concepts and Principles: Growth and development- definition, parameters of growth and development, growth dynamics and morphogenesis.					
Block 2: Environment and Development					
Unit: I					
Climatic Factors, Hormones and Developmental Physiology: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and thermoperiodism. Assimilate partitioning, influence of water and mineral nutrition in growth and development; concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brassinosteroids, other New PGRs. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.					
Block 3: Stress management					
Unit: I					
Strategies for Overcoming Stress: Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations and commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development.					
Practical					
Understanding dormancy mechanisms in fruit crops and seed stratification. Techniques of growth analysis. Evaluation of photosynthetic efficiency under different environments. Exercises on hormone assays. Practicals on use of growth regulators Understanding ripening phenomenon in fruits. Study on impact of physical manipulations on growth and development. Study on chemical manipulations on growth and development. Understanding stress impact on growth and development					
References					

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Course Code	Systematics of Fruit Crops	L	T	P	C
24HO3135		2	0	1	3
Course Objectives:					
Enable the students to					
1.Gain knowledge on nomenclature and classification of fruit crops					
2.Analyze the descriptors and apply methods to identify cultivated and wild species of fruit and nut crops					
3. Apply chemotaxonomy, biochemical and molecular markers for identification and list the registration protocols					
Course Outcomes:					
The students will be able to					
1. Classify and name the different fruit crops based on biosystematics procedures					
2. Analyze different methods to identify and describe cultivated, wild fruit and nut species					
3. Develop and document botanical and pomological descriptors of major cultivars and root stocks					
4. Categorize fruit crop species and genotypes based on phylogenetics and chemotaxonomy					
5. Apply biochemical and molecular markers to classify fruit crop species					
6. Apply protocols for registration of new fruit varieties					
Theory					
Block 1: Biosystematics					
Unit: I					
Nomenclature and Classification: Biosystematics – introduction and significance; history of nomenclature of cultivated plants, classification and nomenclature systems; International code of nomenclature for cultivated plants					
Block 2: Botanical Keys and Descriptors					
Unit: I					
Identification and Description: Methods of identification and description of cultivated fruit and nut species and their wild relatives’ features; development of plant keys for systematic identification and classification. Development of fruit crop descriptors- based upon Bioversity International Descriptors and UPOV/ DUS test guidelines, botanical and pomological description of major cultivars and rootstocks of tropical, subtropical and temperate fruits and nut crops					
Block 3: Special Topics					
Unit: I					
Registration and Modern Systematics: Registration, Use of chemotaxonomy, biochemical and molecular markers in modern systematics					

Practical	
Exercises on identification and pomological description of various fruit species and cultivars: Development of descriptive blanks vis-a-vis UPOV/ DUS test guidelines and Bioversity International: Descriptors for developing fruit species and cultivar descriptive databases: Visits to major germplasm centres and field genebanks.	
References	
1. ASHS. 1997. <i>The Brooks and Olmo Register of Fruit and Nut Varieties</i>. 3rd Ed. ASHS Press. 2. Bhattacharya B and Johri BM. 2004. <i>Flowering Plants: Taxonomy and Phylogeny</i>. Narosa Pub. House, New Delhi. 3. Pandey BP. 1999. <i>Taxonomy of Angiosperms</i>. S. Chand & Co. New Delhi. 4. Pareek OP and Sharma S. 2017. <i>Systematic Pomology</i>. Scientific Publishers, Jodhpur. 5. Sharma G, Sharma OC and Thakur BS. 2009. <i>Systematics of Fruit Crops</i>. NIPA, New Delhi. 6. Simpson M. 2010. <i>Plant Systematics</i>. 2nd Edn. Elsevier. 7. Spencer RR, Cross R and Lumley P. 2003. <i>Plant Names</i>. 3rd Ed. <i>A Guide to Botanical Nomenclature</i>, CISRO, Australia. 8. Srivastava U, Mahajan RK, Gangopadhyay KK, Singh M and Dhillon BS. 2001. <i>Minimal Descriptors of Agri-Horticultural Crops. I: Fruits</i>. NBPGR, New Delhi. 9. Zielinski QB. 1955. <i>Modern Systematic Pomology</i>. Wm. C. Brown Co., Iowa, USA.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Nutrition of Fruit Crops	L	T	P	C
24HO3136		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on the concepts and principles of fruit crop nutrition					
2. Evaluate the nutritional requirement of fruit crops					
3. Adopt various techniques of nutrient application in fruit crops					
Course Outcomes:					
The students will be able to					
1. Understand the significance of fruit crop nutrition and factors affecting nutritional uptake					
2. Analyze the symptoms and identify the deficiency disorders in fruit crops					
3. Evaluate the nutritional requirement of macro and micro nutrients					
4. Adopt diagnostic and interpretation techniques to identify nutritional deficiency and toxicity					
5. Recommend corrective measures to overcome deficiency and toxicity disorders					
6. Adopt integrated nutrient management practices involving fertigation and biofertilizer application					
Theory					
Block 1: Introduction					
Unit: I					
General Concepts and Principles: Importance and history of nutrition in fruit crops, essential plant nutrients, factors affecting plant nutrition; nutrient uptake and their removal from soil					
Block 2: Requirements and Applications					
Unit: I					
Diagnostics, Estimation and Application: Nutrient requirements, root distribution in fruit crops, soil and foliar application of nutrients in major fruit crops, fertilizer use efficiency. Methods and techniques for evaluating the requirement of macro- and micro-elements, Diagnostic and interpretation techniques including DRIS. Role of different macro and micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders.					
Block 3: Newer Approaches					
Unit: I					
Integrated Nutrient Management (INM): Fertigation in fruit crops, biofertilizers and their use in INM systems.					
Practical					
Visual identification of nutrient deficiency symptoms in fruit crops: Identification and application of organic, inorganic and bio-fertilizers; Soil/ tissue collection and preparation for macro- and micro-nutrient					

analysis; Analysis of soil physical and chemical properties- pH, EC, Organic carbon; Determination of N, P, K and other macro- and micronutrients; Fertigation in glasshouse and field grown horticultural crops; Preparation of micro-nutrient solutions, their spray and soil applications.

References

1. Atkinson D, Jackson JE and Sharples RO. 1980. *Mineral Nutrition of Fruit Trees*.
2. Butterworth Heinemann, Bould C, Hewitt EJ and Needham P. 1983. *Diagnosis of Mineral Disorders in Plants Vol.1 principles*. Her Majesty's Stationery Office, London.
3. Cooke GW. 1972. *Fertilizers for maximizing yield*. Grenada Publishing Ltd, London.
4. Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley Eastern Ltd.
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7. Mengel K and Kirkby EA. 1987. *Principles of Plant Nutrition*. 4th Ed. International Potash Institute, Worblaufen-Bern, Switzerland.
8. Prakash M. 2013. *Nutritional Disorders in Fruit Crops: Diagnosis and Management*. NIPA, New Delhi.
9. Tandon HLS. 1992. *Management of Nutrient Interactions in Agriculture*. Fertilizer Development and Consultation Organization, New Delhi.
10. Westerman RL. 1990. *Soil Testing and Plant Analysis*, 3rd Ed. Soil Science Society of America, Inc., Madison, WI.
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Approved by the Academic Council	24.02.2024

Course Code	Biotechnology of Fruit Crops	L	T	P	C
24HO3137		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on principles of growth and development of plant cell, tissue and organ culture					
2. Practice various methods of in-vitro callus, tissue and organ culture					
3. Acquaint with the various genetic engineering tools and techniques for breeding of fruit crops					
Course Outcomes:					
The students will be able to					
1. Understand the basics and significance of plant cell, tissue and organ culture					
2. Analyze the influence of explant source, media and its components and culture conditions for micropropagation of fruit crops					
3. Evaluate the various methods and stages of callus, organ and protoplast cultures					
4. Analyze various in-vitro methods for production of secondary metabolites using cell suspension cultures					
5. Demonstrate hardening techniques for ex-vitro establishment of tissue cultured plants					
6. Apply the principles of genetic engineering technologies in breeding of fruit crops					
Theory					
Block 1: General Background					
Unit: I					
Introduction, History and Basic Principles: Introduction and significance, history and basic principles, influence of explant material, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.					
Block 2: Tissue Culture					
Unit: I					
In-vitro Culture and Hardening: Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture. Use of bioreactors and in-vitro methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues. Hardening and ex vitro establishment of tissue cultured plants.					

Block 3: Genetic Manipulation
Unit: I

In-vitro Breeding, Transgenics and Gene Technologies: Somatic cell hybridisation, construction and identification of somatic hybrids and cybrids, wide hybridization, *in-vitro* pollination and fertilization, haploids, *in-vitro* mutation, artificial seeds, cryopreservation, *In-vitro* selection for biotic and abiotic stress. Genetic engineering- principles and methods, transgenics in fruit crops, use of molecular markers and genomics. Gene silencing, gene tagging, gene editing, achievements of biotechnology in fruit crops.

Practical

An exposure to low cost, commercial and homestead tissue culture laboratories; Media preparation, Inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus; Sub-culturing techniques on anther, ovule, embryo culture, somaclonal variation; *In-vitro* mutant selection against abiotic stress; Protoplast culture and fusion technique; Development of protocols for mass multiplication; Project development for establishment of commercial tissue culture laboratory

References

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2. Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction*. Blackwell Publishing, USA.
3. Chahal GS and Gosal SS. 2010. *Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches*. Narosa, New Delhi.
4. Chopra VL and Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications*. Oxford & IBH, New Delhi.
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7. Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. NIPA, New Delhi.
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11. Peter KV. 2013. *Biotechnology in Horticulture: Methods and Applications*. NIPA, New Delhi.
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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	24.02.2024

Course Code	Organic Fruit Culture	L	T	P	C
24HO3138		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on the basic principles of Organic Fruit production					
2. Practice Organic Farming systems in fruit crops					
3. Acquaint with the organic certification procedures					
Course Outcomes:					
The students will be able to					
1. Understand the scope and principles of organic farming of fruit crops					
2. Analyze the various organic farming practices					
3. Evaluate the organic procedures for soil health management and Plant Protection					
4. Estimate the economics of organic fruit production					
5. Assess the global market demand for fresh and processed organic fruit produce					
6. Explain International certifications and documentation procedures for sale of organic fruit produce					

Theory	
Block 1: General Aspects	
Unit: I	
Principles and Current Scenario: Organic horticulture, scope, area, production and world trade, definition, principles, methods and SWOT analysis.	
Block 2: Organic Culture	
Unit: I	
Farming System and Practices: Organic farming systems including biodynamic farming, natural farming, homa organic farming, rishi krishi, EM technology, cosmic farming; on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes, inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management. Organic seeds and planting materials, soil health management in organic production, weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops.	
Block 3: Certification	
Unit: I	
Inspection, Control Measures and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification), transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of custody, certification trademark – The Logo, accredited certification bodies under NPOP. Constraints in certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production.	
Practical	
Design of organic orchards/ farms management ; Conversion plan: Nutrient management and microbial assessment of composts and bio-enhancers; Preparation and application of composts, bio-enhancers and bio-pesticides: Organic nursery raising; Application of composts, bio-enhancers, bio-fertilisers and bio-pesticides, green manure, cover, mulching; Preparation and use of neem based products; Biodynamic preparations and their role in organic agriculture, EM technology and products, biological/ natural management of pests and diseases; Soil solarisation; Frame work for GAP; Documentation for certification.	
References	
1. Claude A. 2004. <i>The Organic Farming Sourcebook</i>. Other India Press, Mapusa, Goa, India. 2. Dabholkar SA. 2001. <i>Plenty for All</i>. Mehta Publishing House, Pune, Maharashtra. 3. Das HC and Yadav AK. 2018. <i>Advances in Organic Production of Fruit Crops</i>. Westville Publishing House, New Delhi. 4. Deshpande MS. 2003. <i>Organic Farming with respect to Cosmic Farming</i>. Mrs. Pushpa Mohan Deshpandey, Kolhapur, Maharashtra. 5. Deshpande WR. 2009. <i>Basics of Organic Farming</i>. All India Biodynamic and Organic Farming Association, Indore. MP. 6. Gaur AC, Neblakantan S and Dargan KS. 1984 <i>Organic Manures</i>. ICAR, New Delhi. 7. Lampkin, N. and Ipswich, S. 1990. <i>Organic Farming</i>. Farming Press. London, UK. 8. Lind K, Lafer G, Schloffer K, Innershofer G and Meister H. 2003. <i>Organic Fruit Growing</i>. CAB International. 9. Palaniappan SP and Annadurai K. 2008. <i>Organic Farming- Theory and Practice</i>. Scientific Publishers, Jodhpur, Rajasthan, India. 10. Palekar S. 2004. <i>The Technique of Spritual Farming</i>. Chandra Smaritee, Sai Nagar, Amrawati, Maharashtra. 11. Proctor P. 2008. <i>Biodynamic Farming and Gardening</i>. Other India Press, Mapusa, Goa. 12. Ram RA and Pathak RK. 2017. <i>Bioenhancers</i>. Lap Lambert Academic Publishing, AP.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Climate Change and Fruit Crops	L	T	P	C
24HO3139		1	0	0	1
Course Objectives:					
Enable the students to					
1. Gain knowledge on the climatic variability and factors affecting climate change					
2. Acquaint the importance of sensors in the assessment of climate change					
3. Recommend mitigation measures to overcome the effects of climate change					
Course Outcomes:					
The students will be able to					
1. Examine the importance of global warming and climate variability					
2. Analyze the factors responsible for climate change					
3. Evaluate the methods to record the climatic parameters					
4. Apply conventional and advanced cultivational practices to overcome the effects of drastic climate					
5. Adopt strategic planning and appropriate measures to tackle invasive insect, disease and weeds					
6. Disseminate practices of sustainable farming in fruits with enhanced yield and quality.					
Theory					
Block 1: General Aspects					
Unit: I					
Introduction, Global Warming and Climatic Variability: Introduction to climate change. Factors directly affecting climate change. Global warming, effect of climate change on spatio-temporal patterns of temperature and rainfall, concentrations of greenhouse gasses in atmosphere. pollution levels such as tropospheric ozone, change in climatic variability and extreme events.					
Block 2: Climate Change and Management					
Unit: I					
Impact Assessment and Mitigation: Sensors for recording climatic parameters, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, longer growing seasons and shifts in plant hardiness for fruit crops. Climate mitigation measures through crop management- use of tolerant rootstocks and varieties, mulching – use of plastic windbreak- spectral changes- protection from frost and heat waves. Climate management in greenhouse- heating – vents – CO2 injection – screens – artificial light. Impact of climate changes on invasive insect, disease, weed, fruit yield, quality and sustainability. Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems.					
Block 3: Case Studies					
Unit: I					
Response to Climate Change: Case studies – responses of fruit trees to climatic variability vis-a-vis tolerance and adaptation; role of fruit tree in carbon sequestration.					
References					
1. Dhillion WS and Aulakh PS. 2011. <i>Impact of Climate Change in Fruit Production</i> . Narendra Publishing House, New Delhi.					
2. Peter KV. 2008. <i>Basics in Horticulture</i> . New India Publishing Agency, New Delhi.					
3. Ramirez F and Kallarackal J. 2015. <i>Responses of Fruit Trees to Global Climate Change</i> . Springer-Verlag.					
4. Rao GSLHV. 2008. <i>Agricultural Meteorology</i> . Prentice Hall, New Delhi.					
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Recommended by the Board of Studies		02.02.2024			
Approved by the Academic Council		24.02.2024			

Course Code	Minor Fruit Production	L	T	P	C
24HO3140		2	0	1	3
Course Objectives:					
Enable the students to					

1. Realise the importance and distribution of minor fruit crops 2. Acquire knowledge on adaptation of minor fruits in varied ecosystems 3. Propagate Minor fruit crops and assess their value addition in processing industries	
Course Outcomes:	
The students will be able to 1. Identify the occurrence of underutilized minor fruit crops and their adaptation in wastelands 2. Analyze the botany and floral biology of minor fruits 3. Adopt traditional and advanced techniques for propagation of minor fruits 4. Acquire skills on analysing fruit set, quality and ripening of minor fruits 5. Commercialize the edible uses, storage and processing techniques of minor fruits 6. Evaluate the post-harvest techniques and processing methods to preserve the medicinal and antioxidant values	
Theory	
Block 1: Introduction	
Unit: I	
Occurrence, Adoption and General Account: Importance – occurrence and distribution, climate adaptation in fragile ecosystem and wastelands.	
Block 2: Agro-Techniques	
Unit: I	
Propagation and Cultural Practices: Traditional cultural practices and recent development in agro-techniques; propagation, botany-floral biology, growth patterns, mode of pollination, fruit set, ripening, fruit quality.	
Block 3: Marketing and Utilization	
Unit: I	
Post-Harvest Management: Post harvest management, marketing; minor fruit crops in terms of medicinal and antioxidant values; their uses for edible purpose and in processing industry	
Practical	
Visits to institutes located in the hot and cold arid regions of the country; Identification of minor fruits plants/ cultivars; Collection of leaves and preparation of herbarium; Allelopathic studies; Generating know-how on reproductive biology of minor fruits; Fruit quality attributes and biochemical analysis; Project formulation for establishing commercial orchards in fragile ecosystems	
References	
1. Ghosh SN, Singh A and Thakur A. 2017. <i>Underutilized Fruit Crops: Importance and Cultivation</i>. Jaya Publication House, New Delhi. 2. Krishna H and Sharma RR, 2017. <i>Fruit Production: Minor Fruits</i>. Daya Publishing House, New Delhi. 3. Mazumdar BC. 2014. <i>Minor Fruit Crops of India: Tropical and Subtropical</i>. Daya Publication House, New Delhi. 4. Nath V, Kumar D, Pandey V and Pandey D. 2008. <i>Fruits for the Future</i>. Satish Serial Publishing House, New Delhi. 5. Pareek OP, Sharma S, and Arora RK. 2007. <i>Underutilised Edible Fruits and Nuts</i>, IPGRI, Rome. 6. Peter KV. 2010. <i>Underutilized and Underexploited Horticultural Crops</i>. NIPA, New Delhi. 7. Rana JC and Verma VD. 2011. <i>Genetic Resources of Temperate Minor Fruit (Indigenous and Exotic)</i>. NBPGR, New Delhi. 8. Saroj PL and Awasthi OP. 2005. <i>Advances in Arid Horticulture</i>, Vol. II: <i>Production Technology of Arid and Semiarid Fruits</i>. IBDC, Lucknow. 9. Saroj PL, Dhanda DG and Vashishta BB. 2004. <i>Advances in Arid Horticulture</i>, Vol.-1 <i>Present Status</i>. IBDC, Lucknow. 10. Singh <i>et al.</i> 2011. <i>Jamun</i>. ICAR, New Delhi.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	24.02.2024

Course Code	Plant Biochemistry	L	T	P	C
24AG3214		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the process of photosynthesis and synthesis of biomolecules from photosynthates 2. Relate the biochemical processes for synthesis and assimilation of nutrients, hormones in plants for the growth and development. 3. Gain insight into the role of secondary metabolities in plant protection					
Course Outcomes:					
The students will be able to					
1. Analyse the mechanism of carbon fixation, synthesis of proteins and lipids for growth and development in plants. 2. Apply the knowledge of nutrient assimilation for growth and modulation of environmental stresses in plants 3. Discuss the biochemical processes during seed germination and fruit ripening 4. Analyse the role/ action of phytohormones for the growth development and in plant stress adaptations. 5. Apply the functions of secondary metabolites for plant adoption to biotic and environmental stress 6. Analyse the effects of abiotic and biotic stresses on plant growth and defense mechanisms					
Theory					
Block 1: Photosynthesis					
Unit: I: Photosynthetic machinery					
Structure and function of plant cell and its organelles, phytochromes, chloroplast morphology structure, structure and chemistry of photosynthetic pigments, light reaction of photosynthesis.					
Unit: II: Photosynthesis – the process					
Carbon reduction in C3, C4 and CAM plants, photorespiration, sucrose-starch interconversion					
Block 2: Conversion of Photosynthates					
Unit: I: Synthesis of major biomolecules					
Biosynthesis of structural carbohydrates, storage proteins and lipids.					
Unit 2: Nitrogen and sulphur metabolism					
Basic concepts of nitrogen and sulphur metabolism: biological nitrogen fixation, nitrate assimilation in plants, sulphur chemistry and function, reductive sulphate assimilation pathway, sulphated compounds.					
Block 3: Growth and Development					
Unit: I: Germination and fruit ripening					
Biochemistry of seed germination – stages, requirements, metabolism and mobilization of storage material; Biochemistry of fruit ripening – ripening process, cell wall degrading enzymes, role of ethylene and regulation of ethylene production					
Unit II: Phytohormones					
Different classes of phytohormones, their biosynthesis and mode of action.					
Block 4: Secondary Metabolites					
Unit 1: Biochemistry of plant secondary metabolites					
Biochemistry and significance of plant secondary metabolites – phenolics, terpenoids, alkaloids, cyanogenic glycosides and glucosinolates, effect of biotic and abiotic factors on plant metabolism and plant defense system.					
Practical					
Fractionation of cell organelles, Estimation of starch, Assay of ADPG pyrophosphorylase/starch synthase; Assay of PAL/SOD; Assay of PPO/LOX, Estimation of individual amino acids; Qualitative tests of secondary metabolites (alkaloids, sterols etc.) Content and composition of carotenoids, anthocyanin and chlorophylls Determination of polyphenols/phenolics; Fractionation of storage proteins; Estimation of glucosinolates; Estimation of cyanogenic compounds.					
References					
1. Buchannan BB, Gruissem W and Jones R.L. (eds.). 2000. <i>Biochemistry and Molecular Biology of Plants</i>. 2nd edition. WILEY Blackwell 2. Heldt, H-W. 2010. <i>Plant Biochemistry and Molecular Biology</i>. 4th ed. Oxford University Press					

3. Goodwin TW and Mercer EI. 2005. <i>Introduction to Plant Biochemistry</i> . 2nd edition. CBS	
4. Heldt, H-W. and Piechulla, B. 2010. <i>Plant Biochemistry</i> . 4th Edition. Elsevier	
5. Harinda, Makkeand Klaus. 2007. <i>Plant Secondary Metabolites</i> . Springer	
6. Cseke LJ, Kirakosyan A, Kaufman PB, Warber S, Duke JA, Brielmann HL. 2006. <i>Natural</i>	
7. <i>Products from Plants</i> . 2ndEdition. CRC Press	
Recommended by the Board of Studies	02.02.2024
Approv-ed by the Academic Council	24.02.2024

Course Code	Physiological and Molecular Responses of Plants to Abiotic Stresses	L	T	P	C
24AG3228		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the effect of abiotic stresses in reducing crop productivity 2. Gain insight into the physiological mechanism of abiotic stress tolerance 3. Understand the molecular basis of abiotic stress tolerance for plant breeding					
Course Outcomes:					
The students will be able to					
1. Examine the abiotic stresses affecting crop productivity and their interaction with biotic stresses 2. Analyse the physiological and biochemical changes that imparts abiotic stress tolerance in crops. 3. Investigate the regulatory mechanisms and key genes for abiotic stress tolerance in crop improvement programs 4. Apply the genes/molecular mechanism that imparts abiotic stress tolerance for research and crop improvement 5. Develop genomic resources for molecular breeding to improve adaptive traits under stress 6. Compare the stress mechanisms at cellular and leaf level and their cross talk under various abiotic stresses					
Theory					
Block 1: Abiotic Stresses					
Unit: I: Introduction to Abiotic Stresses					
Abiotic stresses major constraints to realize potential yields of crop plants, yield losses. Drought prone areas in India- Frequency of occurrence of drought, Rainfed kharif, Rabi, Areas affected by salinity, heavy metals, water logging, high temperature scenario due to global warming.					
Block 2: Drought Stress					
Unit: I: Moisture Stress Responses in Plants					
Drought-characteristic features; water potential in the soil-plant-air continuum. Physiological and biochemical processes affected by drought. Oxidative stress generation of ROS and other cytotoxic compounds, their effect on cellular process. Effect on total carbon gain- decrease in photosynthetic area and function, protein turn over and lipid characters, phenology-reproductive aspects, critical stages.					
Unit: II: Stress Perception and Molecular Responses of Plants to Drought Stress					
Stress perception and signal transduction leading to expression of regulatory genes, stress specific kinases, stress specific transcription factors, functional genes associated with adaptive mechanisms.					
Unit: III: Plant Adaptive Mechanisms to Drought					
(a) Escape and desiccation avoidance mechanism, Concept of stress escape- exploiting genetic variability in phenology, Drought avoidance mechanisms- Maintenance of cell turgor, water mining by root characters. Moisture conservation- Regulation of transpiration- traits reducing heat load, Stomatal factors guard cell metabolism, moisture conservation by waxes. Water use efficiency (WUE) and concept of water productivity- regulation of transpiration efficiency stomatal conductance, mesophyll efficiency, relevance of WUE and Passioura's model. (b) Desiccation tolerance- Concept of acquired tolerance Decreased turgor mediated upregulation of cellular tolerance mechanisms, Osmolytes, managing cytotoxic compounds, ROS, RCC, scavenging - enzymatic and non-enzymatic, protein turnover, stability, chaperones, membrane stability, photoprotection of chlorophylls.					
Unit: IV: Approaches to Improve Drought Tolerance					
Development of genetic resources- donor genotypes for specific traits, Genomic resources- genes, QTL's regulating adaptive mechanisms, Conventional, transgenic and molecular breeding approaches to improve relevant adaptive traits, concept of trait introgression.					

Block 3: Salt, Heavy Metal, Water Logging, Temperature and Light Stress

Unit: I: Salt Stress

Soil salinity-Effect of salt stress, ionic and osmotic effects; species variation in salt tolerance; glycophytes and halophytes, Salt tolerance mechanisms - exclusion, extrusion and compartmentalization, Signalling during salt stress – SOS pathway, Approaches to improve salt tolerance.

Unit: II: Heavy Metal Stress and Water Logging

Heavy metal toxicity in plants (eg., Al, Cd), tolerance mechanisms and approaches to improve. Plant response to water logging, role of hormones- ethylene, mechanism of tolerance and approaches to improve.

Unit: III: Temperature and Light Stress

High and low temperatures; effect on plants; adaptive mechanisms, evaporation cooling, concept of cellular tolerance, protein stability, chaperones, HSPs, HSFs, membranes. High light and high ionizing radiation- photo oxidation and photoinhibition; mechanisms of tolerance, plant adaptation to low light, concept of shade avoidance response (SAR).

Practical

Measurement of soil and plant water status, Drought stress imposition and measurement of physiological and biochemical, changes in plants under stress –gas exchange and fluorescence measurements, Determination of water use efficiency as a drought resistant trait, Drought Susceptibility Index (DSI) - precise field technique to identify productive, genotypes under stress, Approaches to quantify root characters, Determination of stomatal parameters and canopy temperature as a reflection of transpiration and root activity, Determination of Salinity Tolerance Index, Studying acclimation response - Temperature induction response, Heat tolerance and membrane integrity- Sullivans heat tolerance test, Quantification of osmolytes – proline under stress, Oxidative stress imposition- Quantification of oxidative stress, Quantification of ROS under stress, Estimation of ABA content in leaf and root tissues under stress, Determination of Sodium and Potassium in plant tissue grown under salt stress, Estimation of antioxidant enzymes.

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Recommended by the Board of Studies

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24.02.2024

Course Code	Analytical Technique and Instrumental Methods in Soil and Plant Analysis	L	T	P	C
24AG3227		0	0	2	2
Course Objectives:					
Enable the students to					
1. Understand the principles of Instrumentation					
2. Prepare common analytical reagents for quantitative and qualitative analysis					
3. Analyse the samples of soil and plant for nutrient potentials					
Course Outcomes:					
The students will be able to					
1. Examine the indicators, standard solutions through titrations					
2. Apply the principles of instruments to optimize biochemical estimations					
3. Analyse the Macro and micronutrients by different standard protocols					
4. Interpret the results of ion exchange capacity in soil and plant samples					
5. Compute the standard graphs and estimate the value in appropriate units					
6. Gain hands-on experience on handling of equipment's for research					
Practical					
Preparation of solutions for standard curves, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling. Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils. Principles of visible, ultra violet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometry; identification of minerals by X-ray by different methods, CHNS analyzer. Electrochemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity. Wet digestion/fusion/extraction of soil with aquaregia with soil for elemental analysis; triacid/di-acid digestion of plant samples; determination of available and total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in soils; determination of total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in plants Drawing normalized exchange isotherms; measurement of redox potential.					
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Recommended by the Board of Studies		02.02.2024			
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Course Code	Experimental Designs	L	T	P	C
24AG3217		2	0	1	3
Course Objectives:					
Enable the students to					
1. Design and implement the agricultural experiments for statistical analysis.					
2. Identify the appropriate statistical tool to analyze the experimental outcome.					
3. Proper interpretation of the results of the statistical analysis					
Course Outcomes:					
The students will be able to					
1. Understand the basic principles of design of experiments.					
2. Apply the principles of designs while framing the field layouts.					

3. Analyze and select optimum experimental design for their field research. 4. Collect the appropriate data from the experiment for the statistical analysis. 5. Interpret the results of the statistical analysis with appropriate suggestions. 6. Remember the various applications of experimental designs	
Theory	
Unit: I	
Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.	
Unit: II	
Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.	
Unit: III	
Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.	
Unit IV	
Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.	
Practical	
Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments, Analysis with missing data, Split plot and strip plot designs.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Data Analysis using Statistical Packages	L	T	P	C
24AG3219		2	0	1	3
Course Objectives:					
Enable the students to					
1. Collect and arrange the data for various statistical packages.					
2. Identify the proper statistical packages for analysis.					
3. Interpret the statistical outcomes with proper inference.					
Course Outcomes:					
The students will be able to					
1. Learn the new and advanced statistical packages for data analysis.					
2. Arrange and import the various datasets into the tools for analysis.					
3. Select the appropriate statistical method for analyzing the dataset.					
4. Understand the procedure for analyzing through statistical packages.					
5. Visualize the statistical results in various diagrams and graphs.					
6. Interpretation of results obtained from analysis.					
Theory					
Unit: I					

Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.	
Unit: II	
Test for normality; Testing of hypothesis using chi-square, t and F statistics and Z-test.	
Unit: III	
Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analysing crossed and nested classified designs.	
Unit: IV	
Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.	
Unit: V	
Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.	
Practical	
Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data, Testing the hypothesis for one sample t -test, two sample t -test, paired t -test, test for large samples - Chi-squares test, F test, one-way analysis of variance; Designs for Factorial Experiments, fixed effect models, random effect models, mixed effect models, estimation of variance components; Linear regression, Multiple regression, Regression plots; Discriminant analysis - fitting of discriminant functions, identification of important variables; Factor analysis. Principal component analysis - obtaining principal component.	
References	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Remote Sensing and GIS Techniques for Soil and Crop Studies	L	T	P	C
24AG3218		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the basic concepts of remote sensing and GIS					
2. Compute data processing and result interpretation					
3. Apply the remote sensing and GIS techniques in soil-water-crop resource mapping					
Course Outcomes:					
The students will be able to					

1. Comprehend the remote sensing and its components 2. Process and interpret aerial photographs and imageries 3. Prepare soil resource inventory using remote sensing techniques 4. Estimate crop area and forecast yield 5. Suggest watershed management 6. Assess drought condition and map land degradation	
Theory	
Unit: I	
Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter, basic concepts and principles; hardware and software requirements; common terminologies of geographic information system (GIS)	
Unit: II	
Sensor systems-camera, microwave radio meters and scanners; fundamentals of aerial photographs and multispectral imaging, hyperspectral imaging, thermal imaging; image processing and interpretations.	
Unit: III	
Application of remote sensing techniques-land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, waste land identification and management.	
Unit: IV	
Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.	
Unit: V	
Applications of GIS for water resources, agriculture, precision farming, disaster management, e-governance, Agricultural Research Information System (ARIS).	
Practical	
Familiarization with different remote sensing equipments and data products, Interpretation of aerial photo graphs and satellite data for mapping of land resources, Analysis of variability of different soil properties with classical and geostatistical techniques, Creation of datafiles in a database programme, Use of GIS for soil spatial simulation and analysis, To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning	
References	
1. Brady NC and Weil RR. 2002. <i>The Nature and Properties of Soils</i>. 13th Ed. Pearson Edu. 2. Elangovan K. 2006. <i>GIS Fundamentals, Applications and Implementations</i>. New India Publ.Agency. 3. Lillesand TM and Kiefer RW. 1994. <i>Remote Sensing and Image Interpretation</i>. 3rd Ed. Wiley. 4. Nielsen DR and Wendroth O. 2003. <i>Spatial and Temporal Statistics</i>. Catena Verlagmbh. 5. Star J and Esles J. 1990. <i>Geographic Information System: An Introduction</i>. Prentice Hall	
Recommended by the Board of Studies	02.02.2024
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Course Code	Microbial Gene Technology	L	T	P	C
23AG3165		2	0	1	3
Course Objectives:					
Enable the students to					
1. Know about the Application aspects of recombinant DNA technology.					
2. Make use of microbe and genetic exploration for agricultural sustainability.					
3. Gain knowledge on microbe-based biotechnology applications.					
Course Outcomes:					
The students will be able to					
1. Demonstrate the molecular concepts in microbial genetics.					
2. Utilize molecular biology tools and techniques.					
3. Explore genetic engineering and genome editing for strain improvement.					
4. Practice advanced analysis in microbial taxonomy and ecology.					
5. Assess various sequencing techniques and platforms					
6. Expertise in the field of microbial biotechnology					
Theory					

Basics of Microbial Genome Molecular concepts in microbial genetics - genetic elements – Molecular aspects of gene expression – genotypic and phenotypic variation – regulation of gene expression – ‘Lac’ operon and operon models. Basic Molecular Analysis Development of microbial molecular biology - tools and techniques-extra chromosomal and chromosomal DNAs - Analysis of DNA-Electrophoresis - DNA manipulative enzymes - Polymerase Chain Reaction (PCR) - different versions of PCR- application of PCR methods. Gene Recombinant Technology Cloning vectors based on plasmids, phages, cosmids, transposons - construction of recombinant DNA molecules- Introduction of recombinant DNA into bacterial cells - Transformation, transduction, conjugation and electroporation – Selection of recombinants. Construction of DNA Library Construction of genomic library and cDNA library - Identification of correct clone through primers, probes & antibodies - DNA sequencing – Methods in Genome sequencing - expression of cloned genes in homologous & heterologous hosts – 16S rRNA, molecular markers, GFP, lacZ, GUS. Advanced Molecular Analysis Application in microbial taxonomy and ecology – Expression in recipient cell – methods of scoring markers – DNA hybridization, southern blotting, western – western blot techniques – screening for DNA polymorphism – RAPD- VNTRs- SSRs- Gene tagging and techniques for DNA finger printing.

Practical

Isolation of bacterial genomic DNA - Isolation of plasmid DNA from bacteria - Agarose gel electrophoresis of DNA - Restriction digestion of DNA -Restriction mapping - Ligation of DNA molecules - Microbial DNA amplification by PCR, random primers, specific primers - Transformation of E. coli-screening of transformants - expression of cloned genes in E. coli- plasmid curing in beneficial microbes-bacterial conjugation-transposon mutagenesis- lysogenic and lytic phage-phage DNA isolation

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- http://highered.mcgrawhill.com/sites/0072835125/student_view0/animations.html
- <http://cwx.prenhall.com/brock/>
- <http://www.cliffsnotes.com/sciences/biology/microbiology>

Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	24.02.2024

Course Code	Comparative and Functional Genomics	L	T	P	C
23AG3237		1	0	1	2
Course Objectives:					
Enable the students to					
1. Learn the application aspects of bioinformatic tools					
2. Major advancements in genomic approaches					
3. Function of genes and protein-protein interaction					
Course Outcomes:					
The students will be able to					
1. Explore various functional elements in the cell					
2. Describe gene transfer techniques and genomic approaches					
3. Compare methods for species detection and evolution					
4. Apply advanced bioinformatic tools in host plant interactions					
5. Assess various NGS sequencing platforms					
6. Expertise in the field of genome editing					
Theory					
Unit I:					

Functional elements, Chromosomes and transposons, Organellar Genomes, Symbiosis, Horizontal gene transfer, Gene duplication, Ploidy, Gene fates, Pan and core genomes, Recombination, Transposons, Gene clustering, SNPs and HapMaps, GWAS. Comparative methods for detection of species / organism relationships, Domain evolution, Study of co-evolution: Plant-insect interactions. Host-parasite interactions, viral evolution.

Unit II:

Pre-and post-genomic era; major advancements in genomic approaches; epigenetics and metagenomics; forward versus reverse genetics, Genome editing approaches and their applications; gene expression analyses and applications. RNAi. DNA chips and their use in transcriptome analysis, qPCR, SAGE, MPSS. Connecting Traits to Genes, and Genes to Functions; protein-protein interaction, and protein networks.

Practical

Getting started on the HPC, Regular expressions, Unix and basic sequence statistics, Databases, Genome browsers, Blast & HMMER, Short sequence alignments, Distance trees, Maximum likelihood trees, Whole Genome Alignments, DotPlots, CoGeWebTool, AntiSMASHWebTool

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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	24.02.2024

LIST OF NEW / REVISED COURSES

S. No.	Discipline	Course Code	Course Title	Credits
1	AGR	21AG3015**	Current Trends in Agronomy (V 1.1)	3(3+0)
2	AGR	24AG3016	Recent Trends in Crop Growth and Productivity	3(2+1)
3	AGR	21AG3017	Irrigation Management (V 1.1)	3(2+1)
4	AGR	24AG3018	Recent Trends in Weed Management	2(2+0)
5	AGR	21AG3019	Integrated Farming Systems for Sustainable Agriculture (V 1.1)	2(2+0)
6	AGR	21AG3020	Soil Conservation and Watershed Management (V 1.1)	3(2+1)
7	AGR	21AG3021	Stress Crop Production (V 1.1)	3(2+1)
8	AGR	24AG3022**	Research and Publication Ethics	2(2+0)
9	BTH	24AG3024	Physiological and Molecular Aspects of Source-Sink Capacity for Enhancing Yield	3(3+0)
10	BTH	24AG4025	Concepts and Application of Omics in Biological	3(3+0)

S. No.	Discipline	Course Code	Course Title	Credits
			Science	
11	AEC	24AG4026	Advanced Design of Experiments	3(2+1)
12	AEC	24AG4027	Modeling technique for forecasting	3(2+1)
13	AGR	24AG4023	Doctoral Seminar I	1(0+1)
14	AGR	24AG4024	Doctoral Seminar II	1(0+1)
15	AGR	21AG3994	Doctoral Research-I	19(0+19)
16	AGR	21AG3995	Doctoral Research-II	19(0+19)
17	AGR	21AG3996	Doctoral Research-III	19(0+19)
18	AGR	21AG3997	Doctoral Research-IV	18(0+18)
19	GPB	24AG4048*	Advances in Plant Breeding Systems	3(3+0)
20	GPB	24AG4039	Advances in Biometrical Genetics	3(2+1)
21	GPB	24AG4040*	Genomics in Plant Breeding	3(3+0)
22	GPB	24AG4041	Breeding Designer Crops	2(1+1)
23	GPB	24AG4042*	IPR and Regulatory Mechanism (e-course)	1(1+0)
24	GPB	24AG4043	Molecular Cytogenetics for Crop Improvement	2(2+0)
25	GPB	24AG3044	Plant Genetic Resources, Conservation and Utilization	2(2+0)
26	GPB	24AG3045	Population Genetics	2(2+0)
27	GPB	24AG3048	Crop Evolution	3(3+0)
28	GPB	24AG3046	Doctoral Seminar I	1(0+1)
29	GPB	24AG3047	Doctoral Seminar II	1(0+1)
30	GPB	21AG3994	Doctoral Research-I	19(0+19)
31	GPB	21AG3995	Doctoral Research-II	19(0+19)
32	GPB	21AG3996	Doctoral Research-III	19(0+19)
33	GPB	21AG3997	Doctoral Research-IV	18(0+18)
34	AEN	24AG3090	Insect Phylogeny and Systematics	3(1+2)
35	AEN	24AG3091	Insect Physiology and Nutrition	3(2+1)
36	AEN	24AG3092	Insecticide Toxicology and Residues	3(2+1)
37	AEN	24AG3093	Bio-inputs for Pest Management	3(2+1)
38	AEN	24AG3094	Insect Ecology and Diversity	3(2+1)
39	AEN	24AG3095	Molecular Entomology	2(1+1)
40	AEN	24AG3096	Acarology	2(1+1)
41	AEN	24AG3097	Insect Behaviour	2(1+1)
42	AEN	24AG3098	Plant Resistance to Insects	2(1+1)
43	AEN	24AG3101	Integrated Pest Management	2(2+0)
44	AEN	24AG3099	Doctoral Seminar I	1(0+1)
45	AEN	24AG3100	Doctoral Seminar II	1(0+1)
46	AEN	21AG3994	Doctoral Research - I	19(0+19)
47	AEN	21AG3995	Doctoral Research – II	19(0+19)
48	AEN	21AG3996	Doctoral Research – III	19(0+19)
49	AEN	21AG3997	Doctoral Research - IV	18(0+18)
50	PAT	24AG3117	Advances in Mycology	3(2+1)
51	PAT	24AG3118	Advances in Plant Virology	3(2+1)
52	PAT	24AG3119	Advances in Plant Pathogenic Prokaryotes	3(2+1)
53	PAT	24AG3120	Molecular Basis of Host-Pathogen Interaction	3(2+1)
54	PAT	24AG3121	Principles and Procedures of Certification	1(1+0)
55	PAT	24AG3122	Plant Biosecurity and Biosafety	2(2+0)
56	PAT	24AG3124	Doctoral Seminar I	1(0+1)
57	PAT	24AG3125	Doctoral Seminar II	1(0+1)
58	PAT	21AG3994	Doctoral Research - I	19(0+19)
59	PAT	21AG3995	Doctoral Research – II	19(0+19)

S. No.	Discipline	Course Code	Course Title	Credits
60	PAT	21AG3996	Doctoral Research – III	19(0+19)
61	PAT	21AG3997	Doctoral Research - IV	18(0+18)
62	SAC	23AG3131	Recent Trends in Soil Physics	2(2+0)
63	SAC	23AG3132	Modern Concept in Soil Fertility	2(2+0)
64	SAC	23AG3133**	Physical Chemistry of Soil	2(2+0)
65	SAC	23AG3134**	Soil Genesis and Micromorphology	2(2+0)
66	SAC	23AG3136	Bio-chemistry of Soil Organic Matter	2(2+0)
67	SAC	23AG3138	Modelling of Soil Plant System	2(2+0)
68	SAC	23AG3135	Clay Mineralogy	3(2+1)
69	SAC	23AG3137	Soil Resource Management	3(3+0)
70	SAC	23AG3139	Recent Trends in Soil Microbial Biodiversity	3(2+1)
71	SAC	23AG3140	Doctoral Seminar I	1(0+1)
72	SAC	23AG3141	Doctoral Seminar II	1(0+1)
73	SAC	21AG3994	Doctoral Research-I	19(0+19)
74	SAC	21AG3995	Doctoral Research-II	19(0+19)
75	SAC	21AG3996	Doctoral Research-III	19(0+19)
76	SAC	21AG3997	Doctoral Research-IV	18(0+18)
78	SAC	23AG3160**	Improvements in Fermentation Technology	3(2+1)
79	SAC	23AG3161	Microbial Physiology and Regulation	2(2+0)
80	SAC	23AG3162**	Recent Developments in Soil Microbiology	2(2+0)
81	SAC	23AG3163	Recent Approaches in Environmental Microbiology	2(2+0)
82	SAC	23AG3164**	Plant- Microbe Interactions	3(2+1)
83	BTH	23AG3166	Functional Genomics and Genes Associated with Few Physiological Process	2(2+0)
84	BTH	23AG3167	Plant phenomics- Next Generation Phenomics Platform	2(2+0)
85	SAC	23AG3168	Doctoral Seminar I	1(0+1)
86	SAC	23AG3169	Doctoral Seminar II	1(0+1)
87	SAC	21AG3994	Doctoral Research-I	19(0+19)
88	SAC	21AG3995	Doctoral Research-II	19(0+19)
89	SAC	21AG3996	Doctoral Research-III	19(0+19)
90	SAC	21AG3997	Doctoral Research-IV	18(0+18)
91	AEC	24AG3170	Advanced Micro Economic Analysis	2(1+1)
92	AEC	24AG3171	Advanced Macro Economic Analysis	2(2+0)
93	AEC	24AG3172	Advanced Econometrics	3(2+1)
94	AEC	24AG3173	Advanced Production Economics	3(2+1)
95	AGR	24AG3022	Research and Publication Ethics	2(2+0)
96	AEC	24AG3174	Advanced Agricultural Marketing and Price Analysis	3(2+1)
97	AEC	24AG3175	Quantitative Development Policy Analysis	2(1+1)
98	AEC	24AG3176	Natural Resource Management	2(2+0)
99	AEC	24AG3177	Environmental Economics	3(2+1)
100	AEC	24AG3178	Operations Research	3(2+1)
101	AEC	24AG3183	Agri Input and Output Marketing	3(2+1)
102	AEC	24AG3179	Doctoral Seminar I	1(0+1)
103	AEC	24AG3180	Doctoral Seminar II	1(0+1)
104	AEC	21AG3994	Doctoral Research-I	19(0+19)
105	AEC	21AG3995	Doctoral Research-II	19(0+19)
106	AEC	21AG3996	Doctoral Research-III	19(0+19)
107	AEC	21AG3997	Doctoral Research-IV	18(0+18)
108	ABM	24AG3181	Econometrics for Agri Business	3 (2+1)
109	ABM	24AG3182	Research Methods I	3 (2+1)

S. No.	Discipline	Course Code	Course Title	Credits
110	ABM	24AG3183	Agri Input and Output Marketing	3 (2+1)
111	ABM	24AG3184	Research Methods II	3 (2+1)
112	ABM	24AG3185	Natural Resource Management	2 (2+0)
113	ABM	24AG3186	Knowledge Management	2 (2+0)
114	ABM	24AG3187	Value Chain Management in Agribusiness	2 (2+0)
115	ABM	24AG3188	Agri-Entrepreneurship and Corporate Governance	1 (1+0)
116	ABM	24AG3189	International Food and Agri Business	2 (2+0)
117	ABM	24AG3190	Communication for Management Teachers	2 (0+2)
118	ABM	24AG3191	Doctoral Seminar I	1(0+1)
119	ABM	24AG3192	Doctoral Seminar II	1(0+1)
120	ABM	21AG3994	Doctoral Research-I	19(0+19)
121	ABM	21AG3995	Doctoral Research-II	19(0+19)
122	ABM	21AG3996	Doctoral Research-III	19(0+19)
123	ABM	21AG3997	Doctoral Research-IV	18(0+18)
124	FSC	24HO4146	Innovative Approaches in Fruit Breeding*	3(3+0)
125	FSC	24HO4147	Modern Trends in Fruit Production*	3(3+0)
126	FSC	24HO4138	Recent Developments in Growth Regulation	3(3+0)
127	FSC	24HO4139	Biodiversity and Conservation of Fruit Crops	3(2+1)
128	FSC	24HO4140	Arid and Dryland Fruit Production	2(2+0)
129	FSC	24HO3141	Advanced Laboratory Techniques	3(1+2)
130	FSC	24HO3144	Abiotic Stress Management in Fruit Crops	3(2+1)
131	FSC	24HO3145	Smart Fruit Production	2(2+0)
132	FSC	24HO3142	Doctoral Seminar -I	1(0+1)
133	FSC	24HO3143	Doctoral Seminar -II	1(0+1)
134	FSC	21HO3994	Doctoral Research-I	19(0+19)
135	FSC	21HO3995	Doctoral Research-II	19(0+19)
136	FSC	21HO3996	Doctoral Research-III	19(0+19)
137	FSC	21HO3997	Doctoral Research-IV	18(0+18)

Course Code	Current Trends in Agronomy (V 1.1)	L	T	P	C
21AG3015		3	0	0	3
Course Objectives:					
Enable the students to 1. Review the recent advances in Agricultural Production. 2. Relate the factors affecting crop production and yield. 3. Comprehend the emerging and modern crop production technologies.					
Course Outcomes:					
The students will be able to 1. Understand about the new developments and innovations in agronomy 2. Apply the advanced crop production techniques and system approaches. 3. Acquire knowledge on the recent trends in organic agriculture and procedures for organic certification 4. Optimize various resource management approaches for conservation agriculture. 5. Gain knowledge on seed production techniques and certification procedures 6. Adopt recent technological applications like GIS, GPS, and remote sensing in crop management					
Theory					
Unit: I					
Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship					
Unit: II					

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labelling and accreditation procedures and ITK in organic farming

Unit: III

Crop residue management in multiple cropping systems; latest developments in plant management Mechanization in crop production: modern agricultural precision tools and technologies, weed management, cropping systems, grassland management, agro-forestry, allelopathy

Unit: IV

GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

Unit: V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy. Conservation agriculture, principles, prospects and importance, potential benefits of CA under climate change scenario, policy issues.

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Recommended by the Board of Studies 02.02.2024

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Course Code	Recent Trends in Crop Growth and Productivity	L	T	P	C
24AG3016		2	0	1	3
Course Objectives:					
Enable the students to					
1. Relate crop growth and productivity with the environment and physiological processes. 2. Become familiar with the physiological parameters of crop analysis. 3. Comprehend crop competitions and concept of plant ideotypes.					
Course Outcomes:					
The students will be able to					
1. Apply the strategies for maximizing solar energy utilization for crop growth and productivity. 2. Acquire knowledge on physiological principles impacting crop growth and productivity. 3. Evaluate the physiological parameters of crop analysis for interpreting the crop growth and development. 4. Compare the principles involved in different cropping systems for assessing the yield advantages.					

5. Utilize competitive relationship and competition functions among plants for agronomic production.	
6. Adopt the concept of plant ideotypes and growth promoters for field crop production	
Theory	
Unit: I	
Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.	
Unit: II	
Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.	
Unit: III	
Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.	
Unit: IV	
Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources	
Practical	
Field measurement of root-shoot relationship in crops at different growth stages; Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth; Computation of harvest index of various crops; Assessment of crop yield on the basis of yield attributing characters; Construction of crop growth curves based on growth analysis data; Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping; Senescence and abscission indices; Analysis of productivity trend in un-irrigated areas; Analysis of productivity trend in irrigated areas	
References	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Irrigation Management (V 1.1)	L	T	P	C
21AG3017		2	0	1	3
Course Objectives:					
Enable the students to					

1. Review the water resources of the country and state 2. Relate soil-water-plant relationships 3. Comprehend the advanced methods of irrigation in modern crop production
Course Outcomes:
The students will be able to 1. Understand the role of water in relation to metabolic and physiological functions of plants. 2. Acquire knowledge on advanced strategies for irrigation management practices 3. Compute the water requirement of modern crop production systems. 4. Evaluate the water quality parameters and management measures. 5. Apply the techniques of efficient water use 6. Utilize the knowledge for the command area development
Theory
Unit: I
Global water resources; Water resources of India, irrigation projects during pre and post-independence period and their significance in crop production; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth
Unit: II
Movement of water in soil-water movement under saturated and unsaturated conditions, Poiseuille's and Darcy's law, general equation of saturated and unsaturated flow of water in soil. Soil-plant-water relationships, evaporation, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity
Unit: III
Water requirement, irrigation needs, factors affecting irrigation need; water use efficiency, Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops
Unit: IV
Soil and plant water potential, SPAC, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation
Unit: V
Crop water stress – water deficits and crop growth, adoptability to the crops. Water availability with relation to nutrient availability.
Unit: VI
Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management
Unit: VII
Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies
Unit: VIII
Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.
Unit: IX
Economic analysis of irrigation and crop planning for optimum use of irrigation water
Unit: X
Crop water production function
Practical
Determination of water infiltration characteristics and water holding capacity of soil profiles; Determination Moisture extraction pattern of crops; Determination of water balance component of transplanted rice by drum culture technique; Determination of consumptive use and water requirement of a given cropping pattern; Determination of crop efficient of one important crop; Planning, designing

and installation of drip irrigation system; Planning, designing and installation of sprinkler irrigation system; Designing of drainage channel; Measurement of irrigation efficiencies; Determination of irrigation timing under different methods of irrigation; Visit to irrigation command area

References

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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Recent Trends in Weed Management	L	T	P	C
24AG3018		2	0	0	2

Course Objectives:

Enable the students to

1. Relate the weeds in different ecosystems and their impact on modern crop production.
2. Comprehend herbicides and their application in integrated weed management.
3. Review the advanced methods of weed management techniques in modern crop production.

Course Outcomes:

The students will be able to

1. Identify the different types of weeds and their ecosystem.
2. Understand the weed biology.
3. Apply the knowledge about herbicides and their effects on modern crop production.
4. Compute the compatibility of different herbicide groups and with different agrochemicals.
5. Recommend the advanced biotechnological tools and concepts in weed management
6. Evaluate various bioassay and other herbicide residue assessment techniques.

Theory

Unit: I

Crop-weed competition in different cropping situations; changes in weed flora, various causes and effects; different methods of weed management. Migration, introduction, adaptation of weeds, Invasive weeds – biology and management. Different mechanisms of invasion – present status and factors influencing weed invasion

Unit: II

Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

Unit: III

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, Degradation of herbicides in soil and plants- factors affecting it, primary and secondary metabolites, residue management of herbicides, adjuvants

Unit: IV

Advances in herbicide products and application techniques and methods; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides; herbicide rotation and herbicide mixtures

Unit: V

Development of transgenic herbicide resistant crops; herbicide development, registration procedures

Unit: VI

Relationship of herbicides with tillage, fertilizer, and irrigation, cropping system; bioherbicides, allelochemical and alleloherbicides, herbicide bioassays. Recent advances in nonchemical weed management including deleterious rhizobacteria, robotics, biodegradable film, etc.

References

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Course Code	Integrated Farming Systems for Sustainable Agriculture (V 1.1)	L	T	P	C
21AG3019		2	0	0	2

Course Objectives:

Enable the students to

1. Relate various enterprises under different agro climatic conditions for sustainable agriculture.
2. Become familiar with improved agronomic practices for different farming systems.
3. Be aware of sustainable agriculture practices.

Course Outcomes:

The students will be able to

1. Understand the concept of farming system and sustainable agriculture.
2. Optimise the components in farming system.
3. Develop different simulation models for intercropping.
4. Compute different farming system models.
5. Evaluate different farming systems for sustainable agriculture.
6. Recommend sustainable crop production for guiding farmers.

Theory

Unit: I

Integrated Farming systems (IFS): definition, scope and importance; classification of IFS based on enterprises as well as under rainfed/irrigated condition in different land situation. farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises

Unit: II

Concept of sustainability in of Integrated farming systems; efficient Integrated farming systems based on economic viability and natural resources – identification and management

Unit: III

Production potential of different components of Integrated farming systems; interaction and mechanism of different production factors; stability of Integrated Farming system based on research/long term information. In different systems, through research; eco-physiological approaches to intercropping. Integration of components and adaptability of different farming system based on land situations and climatic condition of a region; evaluation of IFS

Unit: IV

Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems. Formation of different Integrated Farming system Models; evaluation of different Integrated Farming system models. Recycling of organic waste in farming system, in IFS

Unit: V

New concepts and approaches of farming system and organic farming; value addition, waste recycling, quantification and mitigation of Green House gases; case studies/ success stories of different Integrated Farming systems. cropping systems and organic farming; case studies on different farming systems. Possible use of ITK in Integrated farming system

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Course Code	Soil Conservation and Watershed Management (V 1.1)	L	T	P	C
21AG3020		2	0	1	3
Course Objectives:					
Enable the students to 1. Comprehend different soil moisture conservation technologies. 2. Know watershed management through a holistic approach. 3. Review adaptation and mitigation strategies, crop planning and crop management techniques under various soil conditions and moisture availabilities.					
Course Outcomes:					
The students will be able to 1. Understand the concepts of soil erosion and soil conservation 2. Implement watershed models 3. Develop drainage systems in agricultural lands 4. Apply the knowledge of different water conservation methods through watershed					

management	
5. Formulate contingent water planning for aberrant weather conditions	
6. Identify cropping systems for watershed areas	
Theory	
Unit: I	
Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion	
Unit: II	
Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; mulching, tillage, cropping system vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts	
Unit: III	
Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas	
Unit: IV	
Land use capability classification, alternate land use systems; agro-forestry; ley farming; <i>jhum</i> management - basic concepts, socio-ethnic aspects, its layout	
Unit: V	
Drainage, methods of drainage, Drainage considerations and agronomic management; rehabilitation of abandoned <i>jhum</i> lands and measures to prevent soil erosion	
Practical	
Study of different types of erosion; Determination of dispersion ratio; Estimation of soil loss by Universal Soil Loss Equation; Estimation of soil loss by wind erosion; Measurement of runoff and soil loss; Field studies of different soil conservation measures; Laying out run-off plot and deciding treatments; Identification of different grasses and trees for soil conservation; Visit to watershed areas; Visit to a soil conservation research centre, demonstration and training centre.	
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Course Code	Stress Crop Production (V 1.1)	L	T	P	C
21AG3021		2	0	1	3
Course Objectives:					
Enable the students to 1. Review various types of stresses in crop production 2. Comprehend strategies to overcome the stresses caused during crop production. 3. Relate various environmental pollutions affecting crop production and its remediation measures.					
Course Outcomes:					
The students will be able to 1. Gain insights on the impact of various crop stresses.					

- Understand crop production techniques in relation to stressful environment. - Identify effective ways to overcome the environmental stresses affecting crop growth and yield - Recommend ways for effective utilization of farm resources under adverse stressful environment conditions - Manage environmental pollution, their effect on crop growth and the quality of produce - Guide farmers to overcome yield losses and crop failures from various stress factors affecting crop production.
Theory
Unit: I
Stress and strain terminology; nature and stress injury and resistance; causes of stress
Unit: II
Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress through, soil and crop manipulations
Unit: III
High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations
Unit: IV
Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations
Unit: V
Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations
Unit: VI
Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations
Unit: VII
Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance
Unit: VIII
Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution
Practical
Determination of electrical conductivity of plant cell sap; Determination of osmotic potential and tissue water potential; Measurement of transpiration rate; Measurement of stomatal frequency; Measurement of Relative Water Content of leaf; Measurement of electrolytic leakage; Growing of plants in sand culture under salt stress for biochemical and physiological studies; Studies on effect of osmotic and ionic stress on seed germination and seedling growth; Measurement of low temperature injury under field conditions; Studies on plant responses to excess water
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Course Code	Research and Publication Ethics	L	T	P	C
24AG3022		2	0	0	2
Course Objectives:					
Enable the students to					
1. Embrace philosophy, ethics and scientific conduct.					
2. Become familiar with open access publishing and publication misconduct.					
3. Comprehend database and research metrics					
Course Outcomes:					
The students will be able to					
1. Follow the ethical principles and philosophical foundations of research.					
2. Demonstrate intellectual integrity and uphold research honesty.					
3. Address scientific misconduct and eliminate redundant publications.					
4. Recognize publication malpractice, predatory publishers, and unscrupulous journals.					
5. Acquainted with open access publishing and related initiatives.					
6. Compare databases such as indexing databases, citation databases, and metrics like h-index, g-index, i10-index, and altmetrics.					
Theory					
Unit: I					
Introduction to philosophy: definition, nature and scope, concept, branches					
Unit: II					
Ethics: definition, moral philosophy, nature of moral judgements and reactions					
Unit: III					
Scientific conduct: Ethics with respect to science and research, intellectual honesty and research integrity, Scientific misconducts- falsifications, fabrications and plagiarism (FFP): Redundant publications: duplicate and overlapping publications, salami slicing; selective reporting and misrepresentation of data					
Unit: IV					
Publication ethics: Defination, introduction and importance. Best practices/standard setting initiatives and guidelines: COPE, WAME, etc., conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, type, violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals					
Unit: V					
Open access publishing: open access publication and initiatives: SHERPA, RoMEO online resource to check publisher copy right and self-archiving policies; software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestions tools viz., JANE, Elsevier Journal Finder, Springer Journal Suggester etc.					
Unit: VI					
Publication misconduct: Group discussions- subject specific ethical issues, FFP, authorship, conflicts of interest, complaints and appeals examples and fraud from India and abroad. Software tools: Use of plagiarism software like Turnitin, Urkund and other open-source software tools					
Unit: VII					

Database and Research metrics: Indexing data base, citation database, web of science, scopus, etc. Impact factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, g-index, i10-index altmetrics

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Course Code	Physiological and Molecular Aspects of Source Sink	L	T	P	C
24AG3024	Capacity for Enhancing Yield	3	0	0	3

Course Objectives:

Enable the students to

1. Understand the mechanism of enhancing crop productivity
2. Gain insight into the physiological relationship of source to sink
3. Understand the molecular basis of photosynthesis and translocation

Course Outcomes:

The students will be able to

1. Examine the factors affecting crop productivity and their interaction with environment
2. Analyse the physiological and biochemical mechanism of photosynthesis and transpiration
3. Investigate the regulatory mechanisms and key genes for photosynthetic efficiency and yield
4. Apply the genes/molecular mechanism that imparts higher yield and productivity
5. Develop genomic resources through molecular breeding for higher crop yield
6. Analyse the canopy architecture and the factors contributing higher crop productivity

Theory

Block 1: Source Size and Function–Basic Concepts, Physiological and Molecular Mechanisms, Genomic Resources to Regulate Source Characters

Unit: I: Source Establishment

Maximize energy capture by improved light interception, light distribution and its Basic Sciences: utilization efficiency, concepts of shade avoidance response (SAR) and option to increase, Increase canopy size by vertical expansion – concept of increasing optimum LAI levels, Concepts of semi-tall varieties with resistance to lodging: traits associated with lodging resistance, Sustain net carbon gain with age – the relevance of stay green character, photon capture and achieve high CO₂ reduction to photon ratio under low light, Options for increasing canopy photosynthesis, Relevance of maintaining cell turgor and nutrient status

Unit: II: Source Function- Photochemical Reactions

Maximize conversion efficiency of intercepted radiation by improving net carbon gain - Emerging solutions to increase carbon fixation rate, improve efficiency of photochemical reaction by - Engineering the pigments to expand PAR spectrum into IR range; reduce antenna size, optimize energy dissipation mechanisms; optimize components of ETC and downstream acceptors; accelerate adaptation for shifting light intensities

Unit: III: Source Function- CO₂ Diffusion and Concentration

Enhance stomatal conductance (gs) and mesophyll conductance (gm) – guard cell metabolism; concepts of leaf mesophyll tissue thickness (SLW), Concepts of VPD responses of gs to enhance duration of photosynthesis during the day, Bicarbonate transports and aquaporins; achieve higher CCM - Engineering C₄ cycle, CAM, cyanobacteria, carboxysomes, algal pyrenoids

Unit: IV: Source Function- Metabolic Engineering of CO₂ Fixation

RuBisCO carbon fixation activity - Increase and optimize kinetics of RuBisCO with enhanced specificity to CO₂, Engineer RuBisCO to minimize feedback regulation by metabolite inhibitors, Increased activation state by improving stability and function of RuBisCO activase; optimize RuBP regeneration – modulate specific enzyme levels. New concepts on photorespiratory synthetic bypass.

Unit: V: Case Studies to Improve Source Capacity

Genetic and genomic resources, genes/QTLs associated with specific yield potential traits and/or photosynthetic mechanisms, Genetic resources to improve source traits case studies

Block 2: Improving Sink Size and Capacity
Unit: I: Sink Establishment
Optimise duration of phenological stages related to sink establishment, genetic and environmental factors, GDD and phenology
Unit: II: Increase the Sink Size by Enhancing the Relevant Constituent Traits
Role of hormones in regulating molecular mechanisms of yield structure development, Genomic and genetic resources developed for regulation/improvement of such traits. – Sink Size: Tillering associated traits, branching patterns/fruitlet points, spikelet number, pod number, fruit number. – Sink development: Basic concepts and molecular mechanisms associated with pollination, fertilization, ovary development in determining the spikelet fertility/sterility components and strategies for engineering seed/fruit size in crop plants
Unit: III: Genetic and Genomic Resources, Genes/ QTLs, Genetic Resources to Improve
Sink Traits- Case Studies. Progress and status in developing genomic and genetic resources of validated genes/ QTLs to improve sink traits- Specific case studies
Unit: IV: Source to Support the Sink Capacity
Canopy architecture to support sink requirements in cereals: plant height, tillering, leaf area, shading or senescence of lower canopy leaves, canopy photosynthesis, Canopy architecture to support sink requirements in Pulses: Leaf senescence, abscission, mobilization of N and other nutrients, Symbiotic N fixation to support sink size and capacity in pulses
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Course Code	Concepts and Application of Omics In Biological Science	L	T	P	C
24AG4025		3	0	0	3
Course Objectives:					
Enable the students to 1. Learn the application aspects of Omics 2. Major advancements in genomic approaches 3. Function of genes and protein-protein interaction					
Course Outcomes:					
The students will be able to 1. Explore various sequencing techniques 2. Describe comparative genomics and proteomics 3. Compare methods for sequence alignments 4. Apply advanced bioinformatic tools for elucidation of metabolic pathways 5. Assess various kinds of RNA analysis 6. Expertise in the field of integrated omics					
Theory					
Unit: I: Protein and Nucleic Acid Sequencing					
Various methods of sequencing including automated sequencing and microarrays, whole genome sequence analysis.					
Unit: II: Genomics – Methods of Analysis and Application					
Comparative genomics, functional genomics, nutrigenomics, transcriptomics, gene identification, gene annotation, pairwise and multiple alignments, application of genomics, quantitative PCR, SAGE, MPSS, microarray, role of bioinformatics in functional genomics					
Unit: III: Proteome Technology					

2D-PAGE, MSMS, MALDI-TOF, comparative proteomics and structural proteomics

Unit: IV: Metabolomics and Ionomics

Elucidation of metabolic pathways, Sample preparation for metabolomics. Techniques involved in metabolite identification- LCMS, NMR, FTIR, MS. Metabolomics in biotic and biotic stress in crop plants, SPE, SPME, metabolic pathway engineering and its application, Concept and application of ionome and ionomics.

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Course Code	Advanced Design of Experiments	L	T	P	C
24AG4026		2	0	1	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on advanced statistical designs					
2. Develop layouts for the advanced designs					
3. Analyse the field data and interpret the results					
Course Outcomes:					
The students will be able to					
1. Explore the basic principles of advanced designs					
2. Apply the principles of designs for framing the field layouts.					
3. Analyze and select optimum experimental designs in research.					
4. Collect the appropriate data from the experiment for the statistical analysis.					
5. Interpret the results of the statistical analysis with appropriate suggestions.					
6. Acquire skills to implement experimental designs in various field experiments					
Theory					
Unit: I					
General properties and analysis of block designs. Balancing criteria. <i>m</i> - associate PBIB designs, and their association schemes including lattice designs – properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs, Mating designs. Structurally Incomplete block designs					
Unit: II					
General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs., Designs for two sets of treatments					
Unit: III					
Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Resolution plans, Regular and irregular fractions					
Unit: IV					
Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking, Canonical analysis and ridge analysis, CCD, Box-Jenkins, Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors					
Unit: V					

Optimality criteria and optimality of designs, robustness of designs against loss of data, outliers, etc.
 Diagnostics in design of experiments

Practical

Analysis of block designs, Analysis of Latin square type designs, group divisible designs, triangular designs, lattice designs. Analysis of fractional replications of factorial experiments, analysis of asymmetrical factorials and block designs with factorial structure. Analysis of second order response surface designs

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Recommended by the Board of Studies 02.02.2024

Approved by the Academic Council 11.05.2024

Course Code	Modeling Technique for Forecasting	L	T	P	C
24AG4027		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the basic principles of mathematical modelling.					
2. Gain knowledge in mathematical modelling methods and techniques.					
3. Perceive the applications of mathematical modelling in agricultural research					
Course Outcomes:					
The students will be able to					
1. Acquire knowledge about the basic types and laws of matrices.					
2. Conceptualize the basics of integral and differential calculus.					
3. Analyse the different kinds of mathematical models.					
4. Analyse and evaluate different growth models in agriculture.					
5. Create the different yield response models.					
6. Evaluate the results of the various mathematical models.					
Theory					
Unit: I					
Empirical and mechanistic models. Nonlinear growth models: monomolecular, logistic, Gompertz, Richards. Applications in agriculture and fisheries					

Unit: II	
Nonlinear estimation: Least squares for nonlinear models, Methods for estimation of parameters like Linearization, Steepest, and Levenberg- Marquardt's Parameterization	
Unit: III	
Two-species systems. Lotka-Volterra, Leslie-Gower and Holling-Tanner non-linear prey-predator models. Volterra's principle and its applications. Gauss competition model	
Unit: IV	
Compartmental modelling - First and second order input-output systems, Dynamics of a multivariable system	
Unit: V	
Forecasting techniques with special reference to agriculture. Forecast based on time series data: exponential smoothing, Box – Jenkins approach and non-linear models. Forecast models using weather parameters, crop weather relationships and their use in yield forecast. Forecast using plant characters	
Unit: VI	
Forecast surveys, between-year models (regression model, Markov chain probability model and group method of data handling) and within-year models. Agrometeorological models: climatic water balance model and crop yield assessment. Forewarning of crop pests and diseases. Application of remote sensing techniques in forecasting. Use of ANN in forecasting	
Practical	
Fitting of mechanistic non-linear models; Application of Schaefer and Fox non-linear models; Fitting of compartmental models. Fitting of forecast models using weather parameters. Time series analysis: plots, decomposition, stationarity tests, exponential smoothing. Univariate Box –Jenkins ARIMA models and seasonal ARIMA models. Forecast models using plant characters, Agrometeorological models for crop forecasting, Markov chain models and ANN models	
References	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Advances in Plant Breeding Systems	L	T	P	C
24AG4048		3	0	0	3
Course Objectives:					
Enable the students to					
1. Comprehend the concepts of advances in plant breeding.					
2. Understand the methodologies and procedures in MAS.					
3. Gain knowledge on germplasm utilization.					
Course Outcomes:					
The students will be able to					
1. Conceptualize various breeding methodologies					
2. Compare the principles and procedures for the formation of a complex population					

- Explore the tools used in MAS - Analyze the various procedures in gene pyramiding - Acquire skills in utilization of germplasm - Examine the trends in breeding for climate change.
Theory
Unit: I
Advances in reproductive biology of crops; Genes governing the whorls formation and various models proposed; Pollen pistil interaction: biochemical and molecular basis, environmental factors governing anthesis and bottlenecks for gene transfer
Unit: II
Plant Breeding methodologies: Classic versus modern; Over view of Pre and Post Mendelian breeding methods in self- and cross-pollinated crops; Molecular and transgenic breeding approaches; doubled haploid breeding, shuttle breeding, forward and reverse breeding, speed breeding, participatory plant breeding, breeding for organic situations
Unit: III
Principles and procedures in the formation of a complex population; Genetic basis of population improvement in crop plants; Recurrent selection methods in self- and cross-pollinated crops and their modifications; Convergent selection, divergent selection; Recurrent selection, usefulness in hybrid breeding programs; Reciprocal recurrent selection; Selection in clonally propagated crops – Assumptions and realities
Unit: IV
Choice of molecular markers for plant breeding efficiency, fingerprinting and genetic diversity assessment, application of MAS for selection of qualitative and quantitative traits; Gene pyramiding, accelerated backcrossing, marker-based utilization of exotic germplasm, introgression libraries
Unit: V
Genetic resources: primary, secondary, tertiary and alien trans gene pool; Molecular and biochemical basis of self-incompatibility and male sterility, nucleocytoplasmic interactions with special reference to male sterility – genetic, biochemical and molecular bases
Unit: VI
Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatibility and sterility in plant breeding – case studies; Fertility restoration in male sterile lines and restorer diversification programs; Conversion of agronomically ideal genotypes into male sterile: Concepts and breeding strategies; Case studies - Generating new cyto-nuclear interaction system for diversification of male sterile; Stability of male sterile lines – Environmental influence on sterility, Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding; Temperature sensitive genetic male sterility and its use heterosis breeding; Apomixis and its use in heterosis breeding; Incongruity: Factors influencing incongruity Methods to overcome incongruity mechanisms
Unit: VII
Breeding for climate change -Improving root systems, abiotic stress tolerance, water use efficiency, flooding and sub-mergence tolerance; Biotic stress tolerance; Nutrient use efficiency, nitrogen fixation and assimilation, greenhouse gases and carbon sequestration; Breeding for bio-fortification
References
- Agarwal RL. 1996. <i>Fundamentals of Plant Breeding and Hybrid Seed Production</i>. Oxford & IBH. - Allard RW. 1966. <i>Principles of Plant Breeding</i>. John Wiley & Sons. - Briggs FN and Knowles PF. 1967. <i>Introduction to Plant Breeding</i>. Reinhold. - Fehr WR. 1987. <i>Principles of Cultivar Development: Theory and Technique</i>. Vol I. Macmillan. - Hayes HK, Immer FR and Smith DC. 1955. <i>Methods of Plant Breeding</i>. McGraw-Hill. - Kang MS and Priyadarshan PM (Edit.). 2007. <i>Breeding Major Food Staples</i>. Blackwell

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12. Simmonds NW. 1979. <i>Principles of Crop Improvement</i> . Longman.	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Advances in Biometrical Genetics	L	T	P	C
24AG4039		2	0	0	1
Course Objectives:					
Enable the students to 1. Comprehend various qualitative, quantitative systems/ techniques related to genetic improvement of crops 2. Gain knowledge on G x E Interaction, mating designs and component analysis 3. Understand the concept of linkage maps and Marker Assisted Selection (MAS)					
Course Outcomes:					
The students will be able to 1. Explore the qualitative and quantitative techniques 2. Evaluate G x E Interaction 3. Construct saturated linkage maps 4. Apply Marker Assisted Selection in plant breeding 5. Utilize advanced software packages. 6. Analyse biometrical data and interpretation					
Theory					
Unit: I Continuous variation-evolutionary studies; Genetic principles of continuous variation, Qualitative and quantitative techniques-differences, population types, approaches; various types of metrics, F ₂ , F _a and mixed; Selection of parents' Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes.					
Unit: II Components of mean- Additive effect, breeding value, coefficient of gene dispersion, dominance; Simple scaling test, expectation of mean of character in various types of families in coupling and dispersed phase; Epistasis- Specification, weighted and un-weighted joint scaling test; Effect of linkage to generation mean, specification of mean to G × E interaction					
Unit: III Component of variances-advantages, variances of different generations, balance sheet of variance; estimation of parameters-weighted and unweighted, least square analysis; random mating population; experimental population-BIPs, NCD-I, II, III, Triple test cross for random mating population and inbreds; Estimates of linkage and non-allelic interactions; Combining ability analysis, Hayman's Approach					
Unit: IV G × E Interaction, stability and adaptability; Advanced models in stability analysis - Pattern analysis – Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Merits and limitation of different stability analysis methods; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes					
Unit: V					

Construction of saturated linkage maps, concept of framework map development; QTLs-different types of markers and mapping populations, linkage maps, mapping- Strategies for QTL mapping - desired populations, statistical methods; MAGIC populations, Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods; Use of advanced software packages for biometrical analysis, interpretation of analysed data

Practical

Generation mean analysis: ABC scaling test and Joint scaling test- Analysis and interpretation; Estimation of variance of different filial generations and interpretations; Diallel analysis: Numerical, graphical and combining ability analysis; Trialallel analysis; NC Designs: Triple test cross analysis; Stability analysis: Eberhart and Russel model; AMMI model - Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes – Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes; Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies; Use of advanced software in biometrical analysis

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Course Code	Genomics in Plant Breeding	L	T	P	C
24AG4040		3	0	0	3
Course Objectives:					
Enable the students to 1. Comprehend the concepts of plant genomics in varietal development 2. Perceive the theoretical and practical knowledge in genome sequencing and the development of molecular map 3. Understand the modern concepts of high-throughput proteomics, metabolomics, and phenomics crop improvement					
Course Outcomes:					
The students will be able to 1. Understand the modern concepts and methods of next-generation sequencing technologies 2. Apply sequence information to develop pipelines for varietal development 3. Adopt genome mapping techniques to identify the causative genes for the trait improvement 4. Acquire skills in advanced and modern molecular approaches in genomic selection					

5. Attain knowledge of molecular markers and marker-assisted selection to develop new climate-resilient varieties 6. Adopt transgene-free advanced genome editing technologies for crop improvement	
Theory	
Unit: I	
Introduction to the plant genomes: nuclear, chloroplast and mitochondrial genomes; Concept of genome size and complexity: C-value paradox, repetitive and unique DNA	
Unit: II	
Genome sequencing: Principles and techniques of conventional approaches and next generation sequencing including sequencing-by-synthesis/ ligation and single molecule real time (SMRT) technologies; Applications of sequence information: structural, functional and comparative genomics; Plant genome projects: Strategies for genome sequencing including shot gun and clone-by-clone method	
Unit: III	
Molecular maps: Use of molecular markers/ SNPs for development of genetic and physical maps; Linkage and LD based gene mapping approaches including gene/ QTL mapping, genome wide association studies (GWAS) and association analysis; Integration of genetic and physical map for map-based cloning of economically important genes. Concept of allele mining; Diversity array technology: concepts and applications	
Unit: IV	
Functional genomics: concept of reverse and forward genetics; Use of activation tagging, transposon tagging, insertional mutagenesis, TILLING and eco TILLING for crop improvement; Genome-wide and gene-specific transcriptomics approaches: serial analysis of gene expression, massively parallel signature sequencing, next generation sequencing, microarray, northern hybridization, RT-PCR, qRT-PCR and molecular beacon	
Unit: V	
Development and management of database; Applications of bioinformatics tools/ software in genomics for crop improvement. Basic concepts of high-throughput proteomics, metabolomics and phenomics	
Unit VI	
Recent transgene free genome editing tools such as CRISPR-Cas9 system, TALENS and ZFNs for crop improvement. Cisgenesis and Intragenesis tools as twin sisters for Crop Improvement; Genomics-based plant breeding: Genome-Wide Genetic Diversity Studies, Identification of molecular markers linked to single Genes and QTL, Marker Assisted Selection (Marker Assisted Backcross Selection, Association mapping, Breeding by Design, Genome selection)	
References	
1. Alonso JM, Stepanova AN. 2015. Plant Functional Genomics: Methods and Protocols. Springer. 2. Chopra VL, Sharma RP, Bhat SR and Prasanna BM. 2007. Search for New Genes. Academic Foundation, New Delhi. 3. Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology— Basic Experiments in Gene and Manipulation. 2nd Ed. Benjamin Publication Co. 4. Primose SB and Twyman RM. 2006. Principles of Gene Manipulation and Genomics. 7th Ed. Wiley-Blackwell Publishing. 5. Sambrook J and Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Laboratory Press. 6. Singh BD. 2005. Biotechnology: Expanding Horizons. Kalyani Publishers, New Delhi. 7. Somers DJ, Langridge P, Gustafson JP. 2009. Plant Genomics: Methods and Protocols. Springer. 8. e-Resources http://gramene.org https://www.arabidopsis.org https://wheat.pw.usda.gov http://ncbi.nlm.nih.gov http://www.maizegenetics.net	
Recommended by the Board of Studies	02.02.2024

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Course Code	Breeding Designer Crops	L	T	P	C
24AG4041		1	0	1	2
Course Objectives:					
Enable the students to 1. Explain the principles of physiological efficiency in crops. 2. Evaluate the effectiveness of biofortification methods for enhancing crop nutrition. 3. Design breeding strategies for specialized traits in crops for industrial and pharmaceutical use.					
Course Outcomes:					
The students will be able to 1. Apply physiological principles to improve crop traits. 2. Analyze and compare various biofortification techniques to enhance crop nutritional content. 3. Develop and propose effective breeding strategies to create crops with unique traits for specific applications. 4. Demonstrate advanced hybridization techniques in crop breeding. 5. Create and evaluate designer crops with enhanced industrial and pharmaceutical applications. 6. Evaluate and recommend biosafety protocols and post-harvest management practices for designer crop production					
Theory					
Unit: I					
Breeding of crop ideotypes; Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins, vaccines, gums, starch and fats					
Unit: II					
Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode; Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement; Breeding for special traits, viz., oil, protein, vitamins, amino acids, etc.; Ecospecific ideotypes, Ideotypes for high and low moisture conditions, low and high input conditions, conversion mechanism of C3 to C4 plants; Determination of genetics of above mentioned traits					
Unit: III					
Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations					
Unit: IV					
Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming					
Unit: V					
Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management					
Practical					
Demonstration of plant responses to stresses through recent techniques; Water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/ drought/ salt shock proteins					
References					
1. Balint A. 1984. Physiological Genetics of Agricultural Crops. AK Ademiaikiado. 2. Hay RK. 2006. Physiology of Crop Yield. 2nd Ed. Blackwell. 3. Pessarakli M. 1995. Handbook of Plant and Crop Physiology. Marcel Dekker.					

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Recommended by the Board of Studies	02.02.2024
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Course Code	IPR and Regulatory Mechanism (E-Course)	L	T	P	C
24AG4042		1	0	0	1

Course Objectives:
Enable the students to

1. Acquire knowledge on Patenting, copyright, trademark, designs and Information Technology Act.
2. Find ways to protect Individual's rights /patent inventions obtained in the process of project work.
3. Gain insight into patenting and copyright for their innovative work

Course Outcomes:
The students will be able to

1. Understand TRIPs and IPR protection
2. Strategize their registration for inventions/designs, in India and abroad.
3. Remember plagiarism, which can be questioned legally
4. Explain UPOV and PPV & FR Act of India
5. Apply, Analyze and use CBD strategies for the Conservation of Biodiversity.
6. Evaluate the strategies for Licensing, MTAs and Research Collaboration Agreements

Theory

Historical perspectives and need for the introduction of Intellectual Property Rights regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

References

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2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
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Course Code	Molecular Cytogenetics for Crop Improvement	L	T	P	C
24AG4043		2	0	0	2

Course Objectives:
Enable the students to

1. Understand the structure and organization of genomes.
2. Apply cytogenetic techniques for genetic analysis, gene mapping, and introgression tracking.
3. Utilize cytogenetics to locate genes, evaluate polyploidy's impact in crop breeding.

Course Outcomes:
The students will be able to

1. Define genome structure, including repetitive sequences, and its organization in nuclear and organellar genomes. 2. Apply cytogenetic techniques for chromosome analysis, genetic mapping, and introgression tracking. 3. Utilize cytogenetics to locate genes, assess polyploidy's impact on crops, and improve crop traits. 4. Determine the behaviour of interspecific and intergeneric crosses in hybridization strategies for crop improvement. 5. Analyse different in vitro morphogenesis techniques for crop improvement. 6. Assess tissue culture techniques and their potential applications in biotic and abiotic stress tolerance	
Theory	
Unit: I	
Organization and structure of genome, Genome size, Organization of organellar genomes, Nuclear DNA organization, Nuclear and Cytoplasmic genome interactions and signal transduction; Inheritance and expression of organellar DNA; Variation in DNA content - C value paradox; Sequence complexity – Introns and Exons, Repetitive sequences, Role of repetitive sequence	
Unit: II	
Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of genes/ genomic segments	
Unit: III	
Pre-breeding and applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchange genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes- linked marker methods; Duplication -production and use; Inversions and location of genes; B/ A chromosome translocations and gene location.	
Unit: IV	
Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and nonallelic interactions; Telocentric method of mapping.	
Unit: V	
Cytogenomics: Concept, tools and techniques for crop improvement; Chromosome sorting; Isolation of specific chromosome for development of molecular maps and gene location	
Unit: VI	
Role of polyploidy in crop evolution and breeding. Auto- and allopolyploids; Distant hybridization, barriers to interspecific and intergeneric hybridization; Behaviour of interspecific and intergeneric crosses.	
References	
1. Clark MS and Wall WJ. 1996. <i>Chromosomes: The Complex Code</i>. Chapman & Hall. 30 June 1996 2. Conger BV. (Ed.). 1981. <i>Cloning Agricultural Plants via in-vitro Techniques</i>. CRC Press. 31 January 2018 3. Constabel F and Vasil IK. (Eds.). 1988. <i>Cell Culture and Somatic Cell Genetics of Plants</i>. Vol. V. Cell Culture and Phytochemicals in Plant Cell Cultures. Academic Press. 4. Gupta P K. 2006. <i>Cytogenetics</i>. Rastogi Publisher 5. Lal R and Lal S. (Eds.). 1990. <i>Crop Improvement Utilizing Biotechnology</i>. CRC Press. 6. Mantel SH and Smith H. 1983. <i>Plant Biotechnology</i>. Cambridge University Press. 7. Sen SK and Giles KL. (Eds.). 1983. <i>Plant Cell Culture in Crop Improvement</i>. Plenum Press. 13 July 2013 8. Yao-Shan F. 2002. <i>Molecular Cytogenetics: Protocols and Application</i>. Human Press.	
Recommended by the Board of Studies	02.02.2024

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11.05.2024

Course Code	Plant Genetic Resources Conservation and Utilization	L	T	P	C
24AG3044		2	0	0	2
Course Objectives:					
Enable the students to					
1. Concepts of plant exploration and collection					
2. Conservation practices of germplasm accessions					
3. Understand the genetic enhancement techniques					
Course Outcomes:					
The students will be able to					
1. Evaluate the concept of gene centres and diversity hotspots					
2. Apply the procedures in germplasm exchange, management and plant quarantine					
3. Realize the importance of germplasm resources for genetic enhancement					
4. Apply breeding and biotechnology tools for gene transfer					
5. Analyse the intellectual property rights and their regulations					
6. Acquire skills for germplasm conservation and evaluation					
Theory					
Unit: I					
Concept of natural reserves and natural gene banks; <i>In situ</i> conservation of wild species in nature reserves: <i>in situ</i> conservation components, factors influencing conservation value, national plan for <i>in situ</i> conservation; <i>in situ</i> conservation of agro-biodiversity on-farm; scientific basis of <i>in situ</i> conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of <i>in situ</i> conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.					
Unit: II					
<i>Ex situ</i> conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for seed multiplication and exchange to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling, clonal repositories, genetic stability under long term storage condition.					
Unit: III					
<i>In-vitro</i> storage, maintenance of <i>in-vitro</i> culture under different conditions, <i>in-vitro</i> bank maintenance for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/ suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of <i>in-vitro</i> gene bank.					
Unit: IV					
Cryopreservation- procedure for handling seeds of orthodox and recalcitrant-cryoprotectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/ dehydration techniques, national facilities, achievements, application of cryopreservation in agricultural, horticultural and forestry crops. Problems and prospects; challenges ahead.					
Unit: V					
Concept and procedure for PGR management, germplasm characterization, evaluation and utilization; Concept of core and mini core; collections and registration of plant germplasm.					
References					
1. Ellis RH, Roberts EH and White Head J. 1980. <i>A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks</i> . FAO/ IBPGR Pl. Genet. Resources News 41-3-18.					
2. Frankel OH and Hawkes JG. 1975. <i>Crop Genetic Resources for Today and Tomorrow</i> . Cambridge University Press, Cambridge.					

3. Paroda RS and Arora RK.1991. <i>Plant Genetic resource Conservation and management</i> , NBPGR, New-Delhi. 4. Simmonds NW. 1979. <i>Principles of Crop Improvement</i> , Longman. 5. Westwood MN. 1986. <i>Operation Manual for National Clonal Germplasm Repository</i> . Processed Report. USDA-ARS and Oregon State Univ. Oregon, USA. 6. Withers LA. 1980. <i>Tissue Culture Storage for Genetic Conservation</i> . IBPGR Tech. Rep. IBPGR, Rome, Italy.	
Recommended by the Board of Studies	02.02.2024
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Course Code	Population Genetics	L	T	P	C
24AG3045		2	0	0	2

Course Objectives:
Enable the students to

1. Understand the structure of population
2. Gain Knowledge on genetic enhancement of cross-pollinated crops
3. Acquire knowledge on gene and genotype frequencies

Course Outcomes:
The students will be able to

1. Understand about insect classification, evolutionary history and cladistics.
2. Relate with the International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.
3. Comprehend the knowledge on the evolution of insects.
4. Apply the concept of phylocode.
5. Analyze the alternative naming systems for insects.
6. Acquire skills on molecular taxonomy and barcoding species.

Theory
Unit: I

Population: Properties of population, Mendelian population; Genetic constitution of a population through time, space, age structure, etc.; Frequencies of genes and genotypes; Causes of change: population size, differences in fertility and viability, migration and mutation.

Unit: II

Hardy-Weinberg equilibrium, Hardy-Weinberg law, Proof and applications of the Hardy-Weinberg law, Test of Hardy-Weinberg equilibrium; Mating frequencies: Non-dominance, Codominance, Snyder's ratio, importance and its effect over random mating in succeeding generations.

Unit: III

Multiple alleles, More than one locus, Sex linked genes; Use of gene and genotypic frequencies evaluation in field population level; Interpretations - Changes of gene frequency, Migration, Mutation, Recurrent and non-recurrent Selection; Balance between selection and mutation; Selection favouring heterozygotes; Overdominance for fitness.

Unit: IV

Mating systems, Random mating population, Non-random mating: selfing –inbreeding coefficient, panmictic index, sib mating, Assortative mating and disassortative mating; Pedigree populations and close inbreeding, Estimation of linkage disequilibrium, Correlation between relatives and estimation of F; Effect of inbreeding and sibbing in cross pollinated crops; Gene substitution and average effects; Breeding value- Genetic drift; Genetic slippage, Co-adapted gene complexes; Homeostasis- Adaptive organization of gene pools; Polymorphism- Balanced and Non-balanced polymorphism, heterozygous advantage- Survival of recessive and deleterious alleles in populations.

References

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5. Mather K and Jinks JL. 1982. <i>Biometrical Genetics</i> . Chapman & Hall.	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Crop Evolution	L	T	P	C
24AG3048		3	0	0	3
Course Objectives:					
Enable the students to 1. Acquire knowledge on Concepts of crop evolution 2. Conceptualize the Domestication of different crops from centers of origin 3. Ploidy level manipulations for crop improvement					
Course Outcomes:					
The students will be able to 1. Gain expertise on evolution of various crop species 2. Comprehend the process of speciation and domestication 3. Analyze the methods for exploiting the natural variation 4. Apply the knowledge on concepts of crop evolution for Crop Improvement 5. Realize the historical domestication events 6. Conserve the genetic base of a crop					
Theory					
Unit: I					
Origin and evolution of species; Centres of diversity/ origin, diffused centres; Time and place of domestication; Patterns of evolution and domestication-examples and Case studies; Domestication and uniformity – Characteristics of early domestication and changes – Concept of gene pools and crop evolution; Selection and Genetic drift – Consequences.					
Unit: II					
Speciation and domestication–The process of speciation, Reproductive isolation barriers; Genetic differentiation during speciation; Hybridization - speciation and extinction; Exploitation of natural variation: Early attempts to increase variation, Distant hybridization and introgression, Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer into cultivated species, tools and techniques; Validation of transferred genes and their expression; Controlled introgressions.					
Unit: III					
Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; Genome organization – Transgenesis in crop evolution, Multifactorial genome, Intragenomic interaction, Intergenomic interaction, Genome introgression; Methods to study crop evolution - Contemporary Methods, Based on morphological features, Cytogenetic analysis, Allozyme variations and crop evolution, DNA markers, genome analysis and comparative genomics.					
Unit: IV					
Evolutionary significance of polyploidy, evolution of crop plants through ploidy manipulations; Polyploids: methods, use of autopolyploids; haploidy and DH-method of production and use, allopolyploids; synthesis of new crops; Case studies – Cereals, Pulses, Oilseeds, vegetables, Fibre crops, Plantation crops, Forage crops, Tuber crops, Medicinal Plants.					
References					
1. Hancock JF. 2004. <i>Plant Evolution and the Origin of Crop Species</i>. 2nd Ed. CABI. 2. Ladizinsky G. 1999. <i>Evolution and Domestication</i>. Springer. 3. Miller AJ. 2007. <i>Crop Plants: Evolution</i>. John Wiley & Sons. 4. Smartt J and Simmonds NW. 1995. <i>Evolution of Crop Plants</i>. Blackwell					

Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Insect Phylogeny and Systematics	L	T	P	C
24AG3090		1	0	2	3

Course Objectives:

Enable the students to

1. Understand the insect classification, phylogenetics, classical and molecular methods.
2. Gain Knowledge on different groups of insects and International Code of Zoological Nomenclature.
3. Acquire knowledge on ethics and procedure for taxonomic publications.

Course Outcomes:

The students will be able to

1. Understand about insect classification, evolutionary history and cladistics.
2. Relate with the International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.
3. Comprehend the knowledge on the evolution of insects.
4. Apply the concept of phylocode.
5. Analyze the alternative naming systems for insects.
6. Acquire skills on molecular taxonomy and barcoding species.

Theory

Unit: I

Detailed study of three schools of classification- numerical, evolutionary and cladistic. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography.

Unit: II

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

Unit: III

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN; scientific ethics. Nomenclature and documentation protocols and procedures; report preparation on new species; deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures.

Unit: IV

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, works on revision of taxa, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular taxonomy, barcoding species and the progress made in molecular systematics.

Practical

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, and construction of taxonomic keys for the selected group; Development of descriptions, photographing, writing diagrams, and preparation of specimens for “type like” preservation, Submission of the collections made of the group; Multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms; Rooting and character polarization for developing cladograms and use of computer programmes to develop cladograms.

References

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2. Dakeshott J and Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer-Verlag, Berlin.

3. Freeman S and Herron JC. 1998. <i>Evolutionary Analysis</i> . Prentice Hall, New Delhi.	
4. Hennig W. 1960. <i>Phylogenetic Systematics</i> . Urbana Univ. Illinois Press, USA.	
5. Hoy MA. 2003. <i>Insect Molecular Genetics: An Introduction to Principles and Applications</i> . 2 nd Ed. Academic Press, New York.	
6. Mayr E and Ashlock PD. 1991. <i>Principles of Systematic Zoology</i> . 2nd Ed. McGraw Hill, NewYork.	
7. Mayr E.1969. <i>Principles of Systematic Zoology</i> . McGraw-Hill, New York.	
8. Quicke DLJ. 1993. <i>Principles and Techniques of Contemporary Taxonomy</i> . Blackie Academic and Professional, London.	
9. Ross HH. 1974. <i>Biological Systematics</i> . Addison Wesley Publ. Co., London.	
10. Wiley EO. 1981. <i>Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists</i> . Columbia Univ. Press, USA.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Insect Physiology and Nutrition	L	T	P	C
24AG3091		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the physiology of various systems includes digestion, reproductive and nervous system 2. Gain knowledge on physiology and biochemistry of insect cuticle and moulting process 3. Acquire knowledge on physiology of insect growth and development					
Course Outcomes:					
The students will be able to 1. Understand the physiology and biochemistry of insect exoskeleton. 2. Acquire knowledge on the mechanism of chitin biosynthesis, chitin-protein interactions in body wall. 3. Understand the physiology of digestive enzymes in phytophagous, wood boring and wool feeding insects. 4. Examine the detailed physiology of nervous, excretion, reproductive, respiratory and circulatory mechanisms. 5. Examine endocrine system and muscle contractions. 6. Analyze the functions of pheromones and semiochemicals in insect growth and development					
Theory					
Unit: I					
Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, hardening of cuticle.					
Unit: II					
Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.					
Unit: III					
Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.					
Unit: IV					
Endocrine system and insect hormones, physiology of insect growth and development- metamorphosis, polymorphism and diapause. Insect behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.					

Practical	
Preparation of synthetic diets for different groups of insects; Rearing of insects on synthetic, semi-synthetic and natural diets; Determination of co-efficient of utilization; Qualitative and quantitative profile of bio-molecules; practicing analytical techniques for analysis of free amino acids of haemolymph; Zymogram analyses of amylase; Determination of chitin in insect cuticle; Examination and count of insect haemocytes.	
References	
1. Ananthkrishnan TN. (Ed.). 1994. Functional Dynamics of Phytophagous Insects. Oxford and IBH, New Delhi. 2. Bernays EA and Chapman RF. 1994. Host-Plant Selection by Phytophagous Insects. Chapman and Hall, London. 3. Kerkut GA and Gilbert LI. 1985. Insect Physiology, Biochemistry and Pharmacology. Vols. IXIII. Pergamon Press, Oxford, New York. 4. Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Association for Advancement of Entomology, Trivandrum, Kerala. 5. Rockstein, M. 1978. Biochemistry of Insects, Academic Press. 6. Simpson, SJ. 2007. Advances in Insect Physiology, Vol. 33, Academic Press (Elsevier), London, UK.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Insecticide Toxicology and Residues	L	T	P	C
24AG3092		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the latest advancements in the field of insecticide toxicology.					
2. Gain knowledge on biochemical and physiological target sites of insecticides.					
3. Acquire knowledge on Pesticide resistance mechanisms in insects.					
Course Outcomes:					
The students will be able to					
1. Understand the penetration and distribution of insecticides in insect systems.					
2. Evaluate the problems associated with pesticide residues in agriculture ecosystem.					
3. Analyze the biochemical and physiological target sites of insecticides in insects.					
4. Apply insecticide laws and standards, and good agricultural practices.					
5. Acquire skills on biochemical and biological techniques for detection of insecticide resistance in insects.					
6. Correlate different methods for estimation of insecticide residues.					
Theory					
Unit: I					
Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Modes of action of newer insecticide molecules; developments in bio-rational approaches; SPLAT; RNAi technology for pest management.					
Unit: II					
Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.					
Unit: III					
Joint action of insecticides; activation, synergism and potentiation					
Unit: IV					
Problems associated with pesticide use in agriculture: pesticide resistance; resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.					
Unit: V					

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; bound and conjugated residues, effect on soil fertility; insecticide laws and standards, and good agricultural practices.	
Practical	
Residue sampling, extraction, clean-up and estimation of insecticide residues by various methods; Calculations and interpretation of data; Biochemical and biological techniques for detection of insecticide resistance in insects; Preparation of EC formulation using neem oil.	
References	
1. Busvine JR. 1971. A Critical Review on the Techniques for Testing Insecticides. CABI, London. 2. Dhaliwal GS and Koul O. 2007. Biopesticides and Pest Management. Kalyani Publishers, New Delhi. 3. Hayes WJ and Laws ER. 1991. Handbook of Pesticide Toxicology. Academic Press, New York. 4. Ishaaya I and Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi. 5. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York. 6. O' Brien RD. 1974. Insecticides Action and Metabolism. Academic Press, New York. 7. Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi. 8. Prakash A and Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Bio-Inputs for Pest Management	L	T	P	C
24AG3093		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the advanced techniques in handling of different bioagents.					
2. Gain knowledge on modern methods of biological control.					
3. Acquire knowledge on cropping system-based pest management in agro-ecosystems.					
Course Outcomes:					
The students will be able to					
1. Understand the scope of classical biological control and augmentative biocontrol.					
2. Identify and classify the biocontrol agents against target pest populations.					
3. Acquire skills on mass culturing techniques of biocontrol agents.					
4. Evaluate the scope of genetically engineered microbes and parasitoids in biological control.					
5. Analyze the various methods of application of biocontrol agents.					
6. Apply the knowledge for overcoming insecticide resistance pest population using biocontrol agents.					
Theory					
Unit: I					
Scope of classical biological control and augmentative bio-control; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of bio-agents <i>vis-à-vis</i> target pest populations.					
Unit: II					
Bio-inputs: mass production of bio-pesticides, mass culturing techniques of bioagents, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.					
Unit: III					

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of bio-control agents, bankable project preparation.

Unit: IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in bio-control agents for introgressing and for progeny selections, breeding techniques of bio-control agents.

Practical

Mass rearing and release of some commonly occurring indigenous natural enemies; Assessment of role of natural enemies in reducing pest populations; Testing side effects of pesticides on natural enemies; Effect of semio-chemicals on natural enemies, breeding of various bio-control agents, performance of efficiency analyses on target pests; Project document preparation for establishing a viable mass-production unit/ insectary; Observation of feeding behaviour acts of predatory bugs/ beetles.

References

1. Burges HD and Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites*. Academic Press, London.
2. Coppel HC and James WM. 1977. *Biological Insect Pest Suppression*. Springer Verlag, Berlin.
3. De Bach P. 1964. *Biological Control of Insect Pests and Weeds*. Chapman and Hall, London.
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Recommended by the Board of Studies 02.02.2024

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Course Code	Insect Ecology and Diversity	L	T	P	C
24AG3094		2	0	1	3

Course Objectives:

Enable the students to

1. Understand the causal factors governing the distribution and abundance of insects.
2. Gain knowledge on ecological characteristics and insect-plant interactions.
3. Acquire knowledge on insect biodiversity and conservation

Course Outcomes:

The students will be able to

1. Understand the population dynamics through Life tables, Leslie matrix, and population projections.
2. Analyze the predator-prey models like Lotka-Volterra and Nicholson-Bailey model.
3. Apply the knowledge for characterization using indices of dispersion and Taylor's power law, including island biogeography
4. Comprehend the knowledge on crop modelling
5. Acquire skills on how to construct and analyze life tables to understand population dynamics
6. Evaluate the scope of insect plant interactions in insect diversity.

Theory

Unit: I

Characterization of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

Unit: II

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses. Host seeking behaviour of parasitoids.

Unit: III

Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

Unit: IV

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies – timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies.

Practical

Methods of data collection under field conditions; Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc.; Calculation of sample sizes by different methods; Fitting Poisson and Negative Binomial distributions and working out the data transformation methods; Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies – Calculation of changes under selection, Demonstration of genetic drift; Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/ Goniozus/ Female Bruchids, etc.; A test of reproductive effort and fitness; Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution; Exercises in development of Algorithms for crop modelling.

References

1. Barbosa P and Letourneau DK. (Eds.). 1988. Novel Aspects of Insect-Plant Interactions. Wiley, London.
2. Elizabeth BA and Chapman RF. 1994. Host-Plant Selection by Phytophagous Insects. Chapman and Hall, New York.
3. Freeman S and Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi.
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Molecular Entomology	L	T	P	C
24AG3095		1	0	1	2
Course Objectives:					
Enable the students to					
1. Acquire knowledge on molecular techniques in entomological research					
2. Gain Knowledge on biotechnological approaches in sericulture and apiculture					
3. Understand genes of interest in entomological research					
Course Outcomes:					
The students will be able to					
1. Understand the techniques used in molecular biology.					
2. Apply DNA and RNA analysis for insect identification.					
3. Identify and classify genes for characters of interest.					
4. Examine the genetic improvement of natural enemies					
5. Acquire skills on insect gene transformation in relation to silkworms and honey bees					
6. Apply resistance management strategy in transgenic crops					
Theory					
Unit: I					
Introduction to molecular biology; techniques used in molecular biology.					
Unit: II					
DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/ nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, <i>Bt</i> and entomopathogenic fungi.					
Unit: III					
Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Transgenic plants for pest resistance and diseases.					
Unit: IV					
Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.					
Unit: V					
DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.					
Practical					
Isolation of DNA/ RNA; Purity determinations, purification of total DNA from animal tissues; Base pair estimation; Agarose gel electrophoresis; Quantitative enzyme profile of alimentary canal; Restriction mapping of DNA; Demonstration of PCR, RFLP and RAPD techniques.					
References					
1. Bhattacharya TK, Kumar P and Sharma A. 2007. Animal Biotechnology. 1st Ed., Kalyani					
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3. Hagedon HH, Hilderbrand JG, Kidwell MG and Law JH. 1990. Molecular Insect Science. Plenum Press, New York.					
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Acarology	L	T	P	C
24AG3096		1	0	1	2
Course Objectives:					
Enable the students to 1. Understand economically important groups of Acari causing damage to crop plants. 2. Acquire knowledge on economical important species of mites in agriculture. 3. Gain knowledge on phytophagous mites using acaricides and predatory mites.					
Course Outcomes:					
The students will be able to 1. Understand the morphology and phylogeny of mites of economic importance. 2. Apply the knowledge on ecology and population dynamics of mites. 3. Identify the taxonomic characteristics of mite species. 4. Analyze the biotic and abiotic factors influencing the population of mites. 5. Acquire skills on mass production and utilization of predatory mites. 6. Correlate the mite species related to veterinary, public health and storage acarology.					
Theory					
Unit: I					
Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.					
Unit: II					
Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.					
Unit: III					
Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.					
Unit: IV					
Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi-identification, isolation and utilization.					
Practical					
Identification of commonly occurring mites up to species, preparation of keys for identification; Collection of specific groups of mites and preparing their identification keys; Rearing phytoseiid mites and studying their role in suppression of spider mites; Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens, etc.					
References					
1. Evans GO.1992. Principles of Acarology. CABI, London. 2. Gerson H and Smiley RL. 1990. Acarine Bio-control Agents- An Illustrated Key and Manual. Chapman and Hall, New York. 3. Gupta SK. 1985. Handbook of Plant Mites of India. Zoological Survey of India, Calcutta. 4. Krantz GW. 1970. A Manual of Acarology. Oregon State University Book Stores, Corvallis, Oregon. 5. Sadana GL. 1997. False Spider Mites Infesting Crops in India. Kalyani Publ. House, New Delhi.					
Recommended by the Board of Studies	02.02.2024				
Approved by the Academic Council	11.05.2024				

Course Code	Insect Behaviour	L	T	P	C
24AG3097		1	0	1	2
Course Objectives:					
Enable the students to					
1. Understand the behavioural responses in natural selection.					
2. Acquire knowledge on adaptability and various survival strategies in insects.					
3. Gain knowledge on manipulating the insect behaviour for pest management.					
Course Outcomes:					
The students will be able to					
1. Correlate the behaviour and behavioural polymorphism in natural selection and genetic control.					
2. Evaluate the concept of insect communication and orientation.					
3. Examine the reproductive and social behaviour in insects.					
4. Analyze the tritrophic interaction.					
5. Apply insect behaviour in communication and defense as a tool for host selection.					
6. Analyze the behavioural manipulation as potential tool in pest management.					
Theory					
Unit: I					
Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.					
Unit: II					
Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.					
Unit: III					
Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behaviour.					
Unit: IV					
Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, co-evolution of plants and insect pollinators. Behaviour in IPM- Concept of super normal stimuli and behavioural manipulation as potential tool in pest management, use of semiochemicals, auditory stimuli and visual signals in pest management.					
Practical					
Quantitative methods in sampling behaviour; Training bees to artificial feeders; Sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees; Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/ <i>Helicoverpa armigera</i> to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.					
References					
1. Ananthkrishnan TN. (Ed.). 1994. <i>Functional Dynamics of Phytophagous Insects</i> . Oxford and IBH, New Delhi.					
2. Awasthi VB. 2001. <i>Principles of Insect Behaviour</i> . Scientific Publ., Jodhpur.					
3. Bernays EA and Chapman RF. 1994. <i>Host-Plant Selection by Phytophagous Insects</i> . Chapman and Hall, London.					
4. Brown LB. 1999. <i>The Experimental Analysis of Insect Behaviour</i> . Springer, Berlin.					

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6. Manning A and Dawkins MS. 1992. <i>An Introduction to Animal Behaviour</i> . Cambridge University Press, USA.	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Plant Resistance To Insects	L	T	P	C
24AG3098		1	0	1	2
Course Objectives:					
Enable the students to 1. Understand the recent advances in resistance of plants to insects. 2. Acquire knowledge on techniques for assessment and evaluation of resistance in crop plants. 3. Gain knowledge on biotechnological approaches in host plant resistance.					
Course Outcomes:					
The students will be able to 1. Acquire skills on techniques and determination of categories of plant resistance. 2. Understand the importance of plant resistance. 3. Analyze the physical and chemical environment factors conferring resistance in plants. 4. Evaluate the mechanisms of resistance for orientation, feeding, oviposition etc., 5. Identify the plant resistance based on genotype expression. 6. Apply the advanced biotechnological tools in host plant resistance.					
Theory					
Unit: I Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species – gene pool; insect sources – behaviour in relation to host plant factors.					
Unit: II Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.					
Unit: III Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker aided selection in resistance breeding.					
Unit: IV Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.					
Practical Understanding mechanisms of resistance for orientation, feeding, oviposition, etc., allelochemical bases of insect resistance; Macroculturing of test insects like aphids, leaf/ plant hoppers, mites and stored grain pests; Field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; Determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.					
References 1. Panda N. 1979. <i>Principles of Host Plant Resistance to Insects</i> . Allenheld, Osum and Co., New York.					

2. Rosenthal GA and Janzen DH. (Eds.). 1979. <i>Herbivores – their Interactions with Secondary Plant Metabolites</i> . Vol. I, II. Academic Press, New York.	
3. Sadasivam S and Thayumanavan B. 2003. <i>Molecular Host Plant Resistance to Pests</i> . Marcel Dekker, New York.	
4. Smith CM, Khan ZR and Pathak MD. 1994. <i>Techniques for Evaluating Insect Resistance in Crop Plants</i> . CRC Press, Boca Raton, Florida	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Integrated Pest Management	L	T	P	C
24AG3101		2	0	0	2
Course Objectives:					
Enable the students to 1. Understand recent problems with alien pest and use of IPM. 2. Acquire knowledge on surveillance and data base management as a tool in IPM. 3. Gain knowledge on successful national and international case histories of integrated pest management.					
Course Outcomes:					
The students will be able to 1. Understand the principles and concepts of IPM. 2. Acquire skills on data base management, simulation techniques and system analysis. 3. Apply new technologies in genetic engineering and their progress in IPM Programs. 4. Analyze the different strategies in pesticide resistance management. 5. Correlate with new technologies and their progress in IPM. 6. Evaluate the scope and limitations of bio-intensive and ecological based IPM Programs.					
Theory					
Unit: I					
Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.					
Unit: II					
Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.					
Unit: III					
Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.					
Unit: IV					
Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.					
References					
1. Dhaliwal GS and Arora R. 2003. <i>Integrated Pest Management – Concepts and Approaches</i>. Kalyani Publishers, New Delhi. 2. Dhaliwal GS, Singh R and Chhillar BS. 2006. <i>Essentials of Agricultural Entomology</i>. Kalyani Publishers, New Delhi. 3. Flint MC and Bosch RV. 1981. <i>Introduction to Integrated Pest Management</i>. Springer, Berlin. 4. Koul O and Cuperus GW. 2007. <i>Ecologically Based Integrated Pest Management</i>. CABI, London. 5. Koul O, Dhaliwal GS and Curperus GW. 2004. <i>Integrated Pest Management –Potential, Constraints and Challenges</i>. CABI, London.					

6. Maredia KM, Dakouo D and Mota-Sanchez D. 2003. <i>Integrated Pest Management in the Global Arena</i> . CABI, London.	
7. Metcalf RL and Luckman WH. 1982. <i>Introduction to Insect Pest Management</i> . John Wiley and Sons, New York.	
8. Norris RF, Caswell-Chen EP and Kogan M. 2002. <i>Concepts in Integrated Pest Management</i> . Prentice Hall, New Delhi.	
9. Pedigo RL. 1996. <i>Entomology and Pest Management</i> . Prentice Hall, New Delhi.	
10. Subramanyam B and Hagstrum DW. 1995. <i>Integrated Management of Insects in Stored Products</i> . Marcel Dekker, New York.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Advances in Mycology	L	T	P	C
24AG3117		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the advances in molecular taxonomy of fungi 2. Acquire knowledge on morphology, reproduction and pathogenic variability of fungi 3. Gain knowledge on fungal biotechnology					
Course Outcomes:					
The students will be able to 1. Review the recent taxonomy of fungi. 2. Comprehend morphological and sexual characters of fungi 3. Analyse the population biology and variability of fungi 4. Understand fungal nuclear and extra nuclear inheritance. 5. Conceptualize the ultra-structure of fungal cell and fungal biotechnology					
Theory					
Unit: I					
General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, chemical (chemotaxonomy), molecular and numerical (computer-based assessment) taxonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti.					
Unit: II					
Population biology, pathogenic variability/ vegetative compatibility. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.					
Unit: III					
Ultra structures and chemical constituents of fungal cells, functions of cell organelles. Mitosis, meiosis, gene action and regulation. Effects of fungal interaction with host plants and other microorganisms; parasitism, symbiosis and commensalism.					
Unit: IV					
Genetic Improvement of Fungal strains. Fungal biotechnology. Fungi mediated synthesis of nano particles – characterization process and application. Mycotoxins problems and its management.					
Practical					
Isolation, purification and identification of cultures, spores and mating type determination; Study of conidiogenesis-Phialides, porospores, arthospores; Study of fruiting bodies in Ascomycotina; Identification of fungi up to species level; Study of hyphal anastomosis; Morphology of representative plant pathogenic genera form different groups of fungi; Molecular characterization of fungi.					
References					
1. Alexopoulos CJ, Mims CW and Blackwell M. 1996. Introductory Mycology. John Wiley & Sons, New York. 2. Dube HC. 2005. An Introduction to Fungi. 3rd Ed. Vikas Publ. House, New Delhi.					

3. Kirk PM, Cannon PF, David JC and Stalpers JA. (Eds.). 2001. Ainsworth and Bisby's Dictionary of Fungi. 9th Ed., CABI, Wallington. 4. Maheshwari R. 2016. Fungi: Experimental Methods in Biology 2 nd edn. CRC Press, US. 5. Ulloa M and Hanlin RT. 2000. Illustrated Dictionary of Mycology. APS, St. Paul, Minnesota. 6. Webster J and Weber R. 2007. Introduction to Fungi. Cambridge University Press, Cambridge.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Advances in Plant Virology	L	T	P	C
24AG3117		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the taxonomy of virus. 2. Gain knowledge on antibody production technology and detection techniques. 3. Acquire knowledge about genome organization, replication, transcription and translational strategies.					
Course Outcomes:					
The students will be able to 1. Comprehend the virus morphology, evolution of new viruses and taxonomy. 2. Analyse the virus-vector relationship. 3. Apply the knowledge on development of immunodiagnostic kits. 4. Conceptualize various molecular tools for detection of pathogenic viruses. 5. Review the genomic organization of various plant viruses. 6. Acquire skills on genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes.					
Theory					
Unit: I Origin, evolution and interrelationship with animal viruses. Virus morphology, structure, architecture, replication (overview of host and viral components required), assembly and virus specific cytological effects in infected plant cells. Mechanisms leading to the evolution of new viruses/ strains: mutation, recombination, pseudo recombination, component re-assortment, etc.					
Unit: II Major vector groups of plant viruses and their taxonomy, virus-vector relationship, molecular mechanism of virus transmission by vectors. Terminologies used in immunology and serology. Classification, structure and functions of various domains of Immunoglobulins. Production of Polyclonal and monoclonal antibodies for detection of viruses. Immuno/ serological assays (Slide agglutination tests, Test tube precipitation test, Double agar diffusion test, ELISA (DAC, DAS, TAS), Dot Immuno Binding Assay, and nucleic acid-based assays for detection of plant viruses.					
Unit: III Polymerase Chain Reaction based (PCR, reverse transcriptase PCR, multiplex PCR, Nested PCR, Real time/ q PCR) and non-PCR based: LAMP, Fluorescent <i>in situ</i> hybridization (FISH), dot blot hybridization. Plant virus genome organization (General properties of plant viral genome-information content, coding and noncoding regions), replication, transcription and translational strategies of pararetroviruses, geminiviruses, tobamo-, poty-, bromo, cucumo, ilar, tospoviruses, satellite viruses and satellite RNA.					
Unit: IV Gene expression, regulation and viral promoters. Genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes. Virus potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture for production of virus free planting materials. Phylogenetic grouping system based on partial/ complete sequences of virus genomes and using of next generation sequencing technology in plant virus discovery.					
Practical					

Purification of viruses, SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation; Acquaintance with different serological techniques (i) DAC- ELISA (ii) DAS-ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA. Nucleic acid isolation, DOT-blot, southern hybridization, probe preparation, and autoradiography; PCR application and viral genome cloning of PCR products, plasmid purification, enzyme digestion, sequencing, annotation of genes, analysis of viral sequences (use of gene bank, blast of viral sequences and phylogeny); Bioinformatics analysis tools for virology (ORF finder, Gene mark, Gene ontology, BLAST, Clustal X/W, Tm pred and Phylogeny programs).

References

1. Davies 1997. Molecular Plant Virology: Replication and Gene Expression. CRC Press, Florida.
2. Fauquet et al. 2005. Virus Taxonomy. VIII Report of ICTV. Academic Press, New York.
3. Gibbs A and Harrison B. 1976. Plant Virology – The Principles. Edward Arnold, London.
4. Jones P, Jones PG and Sutton JM. 1997. Plant Molecular Biology: Essential Techniques. JohnWiley & Sons, New York.
5. Khan J A and Dijkstra. 2002. Plant Viruses as Molecular Pathogens. Howarth Press, NewYork.
6. Maramorosch K, Murphy FA and Shatkin AJ. 1996. Advances in Virus Research. Vol. 46. Academic Press, New York.
7. Pirone TP and Shaw JG. 1990. Viral Genes and Plant Pathogenesis. Springer Verlag, NewYork.
8. Roger Hull. 2002. Mathew's Plant Virology (4th Ed.). Academic Press, New York.
9. Thresh JM. 2006. Advances in Virus Research. Academic Press, New York.

Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Advances in Plant Pathogenic Prokaryotes	L	T	P	C
24AG3119		2	0	1	3

Course Objectives:

Enable the students to

1. Gain knowledge on the latest taxonomy of phytopathogenic bacteria.
2. Understand the bacterial genetics, their variability and metabolism.
3. Review host defence mechanism and genetic engineering for bacterial disease management

Course Outcomes:

The students will be able to

1. Comprehend the current trends in taxonomy and analyse the detection methods for identification of bacterial plant pathogen.
2. Conceptualize bacterial genetics and their variability
3. Administer knowledge on bacteriophages and molecular mechanism of pathogenesis
4. Conceptualize plant immunization and resistance.
5. Understand the bacterial secretion systems and quorum sensing
6. Evaluate the beneficial prokaryotes and advanced management of bacterial diseases using genetic engineering, RNA silencing, CRISPR cas9.

Theory

Unit: I

Prokaryotic cell: Molecular basis for origin and evolution of prokaryotic life, RNA world, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation. Structure and composition (**bacteria**) cell wall/ envelop, Types of secretion systems (TI to TIV) and their molecular interaction, fimbriae and pili (Type IV pili), Bacterial chromosomes and plasmids, other cell organelles. Growth, nutrition and metabolism in prokaryotes (Embden-Meyerhof-Parnas (EMP) pathway, Phosphoketolase Pathway and Entner Doudoroff Pathway).

Unit: II

Current trends in taxonomy and identification of phytopathogenic prokarya: International code of nomenclature, Polyphasic approach, New/ special detection methods for identification of bacterial plant pathogens. Taxonomic ranks hierarchy; Identification, Advances in classification and nomenclature.	
Unit: III	
Bacterial genetics: General mechanism of variability (mutation), specialized mechanisms of variability. Transposable genetic elements in bacteria-integron and prophages, Mechanism of gene transfer. Pathogenicity islands, horizontal gene transfer, Bacterial Pan-Genome	
Unit: IV	
Bacteriophages: Composition, structure and infection. Classification and use of phages in plant pathology/ bacteriology. Host pathogen interactions: Molecular mechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker, etc. Immunization, induced resistance/ Systemic Acquired Resistance, Quorum sensing. Bacterial pathogenicity and virulence: Molecular mechanism of virulence and pathogenesis, bacterial secretion systems, pathogenicity of bacterial enzymes that degrade the cell walls, Role of hrp/ hrc genes and TALE effectors. Synthesis and regulation of EPSs.	
Unit: V	
Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence. Advances in management of diseases caused by prokaryotes: genetic engineering, RNA silencing; CRISPR cas9.	
Practical	
Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RFLP profiling of bacteria and variability status, Endospore, Flagella staining, Test for secondary metabolite production, cyanides, EPS, siderophore, specific detection of phytopathogenic bacteria using species/ pathovar specific primers; Basic techniques in diagnostic kit development, Molecular tools to identify phyto endosymbionts; Important and emerging diseases and their management strategies.	
References	
1. Dale JW and Simon P. 2004. Molecular Genetics of Bacteria. John Wiley & Sons, New York. 2. Garrity GM, Krieg NR and Brenner DJ. 2006. Bergey's Manual of Systematic Bacteriology: The Proteobacteria. Vol. II. Springer Verlag, New York. 3. Gnanamanickam SS. 2006. Plant-Associated Bacteria. Springer Verlag, New York. 4. Mount MS and Lacy GH. 1982. Plant Pathogenic Prokaryotes. Vols. I, II. Academic Press, New York. 5. Sigeo DC. 1993. Bacterial Plant Pathology: Cell and Molecular Aspects. Cambridge Univ. Press, Cambridge. 6. Starr MP. 1992. The Prokaryotes. Vols. I-IV. Springer Verlag, New York.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Molecular Basis of Host-Pathogen Interaction	L	T	P	C
24AG3120		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the advanced techniques in Molecular Plant Pathology.					
2. Gain knowledge on the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.					
3. Acquire knowledge on genetic engineering approach for management of plant disease.					
Course Outcomes:					
The students will be able to					
1. Conceptualize the mechanism of host-pathogen interactions.					
2. Comprehend induction of defense response and induced systemic resistance.					

3. Acquire skills on methods of gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection. 4. Acquire knowledge on the pathogenesis related proteins and gene silencing. 5. Analyze the gene-for-gene hypothesis R and Avr gene. 6. Evaluate the Biotechnology method of disease management	
Theory	
Unit: I	
History of host plant resistance and importance to Agriculture. Importance and role of biotechnological tools in plant pathology. Basic concepts and principles to study host pathogen relationship. Molecular genetics, imaging and analytical chemistry tools for studying plants, microbes, and their interactions.	
Unit: II	
Different forms of plant-microbe interactions and nature of signals/ effectors underpinning these interactions. Plant innate immunity: PAMP/ DAMP. Molecular basis of host-pathogen interaction-fungi, bacteria, viruses and nematodes; recognition system, signal transduction.	
Unit: III	
Induction of defence responses- HR, Programmed cell death, reactive oxygen species, systemic acquired resistance, induced systemic resistance, pathogenesis related proteins, phytoalexins and virus induced gene silencing. Molecular basis of gene-for- gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes. Gene for gene systems: Background, genetics, phenotypes, molecular mechanisms, races, breakdown of resistance (boom-and-bust cycles), Coevolution-arms race and trench warfare models, Metapopulations, cost of resistance, cost of unnecessary virulence, GFG in agricultural crops vs. natural populations, Durability of resistance, erosion of quantitative resistance.	
Unit: IV	
Pathogen population genetics and durability, viruses vs cellular pathogens. Gene deployment, cultivar mixtures. Disease emergence, host specialization. Circadian clock genes in relation to innate immunity. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops	
Practical	
Protein, DNA and RNA isolation, plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation; Gene mapping and marker assisted selection; Development and use of molecular markers in identification and characterization of resistance to plant pathogens and their management.	
References	
1. Chet I. 1993. Biotechnology in Plant Disease Control. John Wiley & Sons, New York. 2. Gurr SJ, McPherson MJ and Bowles DJ. (Eds.). 1992. Molecular Plant Pathology – A Practical Approach. Vols. I & II, Oxford Univ. Press, Oxford. 3. Mathew JD. 2003. Molecular Plant Pathology. Bios Scientific Publ., UK. 4. Ronald PC. 2007. Plant-Pathogen Interactions: Methods in Molecular Biology. Humana Press, New Jersey. 5. Stacey G and Keen TN. (Eds.). 1996. Plant Microbe Interactions. Vols. I-III. Chapman & Hall, New Y	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Principles and Procedures of Certification	L	T	P	C
24AG3121		1	0	0	1
Course Objectives:					
Enable the students to					
1. Acquire knowledge on certification procedures for seed and planting material					
2. Understand the National regulatory mechanism and seed certification standards					

3. Impart knowledge on seed health testing procedures	
Course Outcomes:	
The students will be able to 1. Comprehend seed certification and international scenario in certification system 2. Evaluate the basics for testing physical and genetic purity of seeds 3. Gain knowledge on quality control specifications in seed certification 4. Conceptualize the national status of seed health in seed certification 5. Apply the knowledge on accreditation procedures for seed testing laboratories 6. Analyze the role of seed certification in national and international trade	
Theory	
Unit: I	
Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD, etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health, etc. Fixing tolerance limits for diseases and insect pests in certification and quality control programmes.	
Unit: II	
Methods used in certification of seeds, vegetative propagules and <i>in-vitro</i> cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.	
References 1. Association of Official Seed Certifying Agencies. Hutchins D and Reeves JE. (Eds.). 1997. 2. Seed Health Testing: Progress Towards the 21st Century. CABI, UK. ISHI-veg Manual of Seed Health Testing Methods. 3. ISHI-F Manual of Seed Health Testing Methods. 4. ISTA Seed Health Testing Methods. 5. Tunwar NS and Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System.	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Plant Biosecurity and Biosafety	L	T	P	C
24AG3122		2	0	0	2
Course Objectives:					
Enable the students to					
1. Gain the knowledge on Plant biosecurity and biosafety issues in agriculture.					
2. Understand the International standards for phytosanitary measures and pest risk analysis					
3. Acquire knowledge on Biosafety policies and regulatory mechanism					
Course Outcomes:					
The students will be able to					
1. Review on the history, concepts and components of biosecurity					
2. Understand national regulatory mechanism and international agreements/ conventions					
3. Conceptualize forecasting system and pest risk assessment models for plant biosecurity					
4. Acquire skills on Global Positioning System and Geographic Information System in plant biosecurity					

5. Administer knowledge on issues related to release of genetically modified crops.	
6. Comprehend the Cartagena protocol on biosafety and its implications	
Theory	
Unit: I	
History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases. Introduction and History of biosecurity and its importance.	
Unit: II	
National Regulatory Mechanism and International Agreements/ Conventions, viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures. World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/ disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.	
Unit: III	
Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops. Emerging/ resurgence of pests and diseases in the changing scenario of climatic conditions. Issues related to release of genetically modified crops.	
References	
1. Biosecurity: A Comprehensive Action Plan. Biosecurity Australia. 2. Biosecurity for Agriculture and Food Production. FAO Biosecurity Toolkit 2008. 3. Grotto Andrew J and Jonathan B Tucker. 2006. Biosecurity Guidance. 4. Khetarpal RK and Kavita Gupta 2006. Plant Biosecurity in India – Status and Strategy. Asian Biotechnology and Development Review 9 (2): 3963. 5. Randhawa GJ, Khetarpal RK, Tyagi RK and Dhillon BS (Eds.). 2001. Transgenic Crops and Biosafety Concerns. NBPGR, New Delhi	
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6. http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml 7. www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory 8. http://www.who.int/csr/resources/publications/biosafety/WHO_CD_S_EPR_2006.pdf 9. http://www.americanprogress.org/kf/biosecurity_ a comprehensive_ action_plan.pdf 10. www.biosecurity.govt.nz DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm 11. www.daff.gov.au/ba ; www.affa.gov.au/biosecurityaustralia Biosecurity New Zealand. 12. http://www.fao.org/biosecurity/ CFIA.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Recent Trends in Soil Physics	L	T	P	C
23AG3131		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand modern concepts of soil-water interactions.					
2. Gain knowledge on soil aeration and thermal properties of soil.					
3. Relate Soil, Plant, Water interactions and energy balance in the field.					
Course Outcomes:					
The students will be able to					
1. Demonstrate soil water interactions and fluid flow in soil.					
2. Illustrate the movement of salts in soils through equations.					
3. Review on soil aeration and thermal properties of soil.					
4. Explain water balance and energy balance in the field.					
5. Appraise on the structural management of soils.					

6. Predict evapotranspiration through canopy temperature-based models.	
Theory	
Unit: I	
Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system, soil-plant-atmospheric continuum (SPAC).	
Unit: II	
Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated waterflow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional waterflow.	
Unit: III	
Theories of horizontal and vertical infiltration under different boundary conditions	
Unit: IV	
Movement of salts in soils, models formiscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.	
Unit: V	
Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil; Soil, Plant, Water relations- Plant uptake of soil moisture, Water balance and energy balance in the field; irrigation and water use efficiency.	
Unit: VI	
Soil crust and clod formation; structural management of puddled rice soils; soil conditioning-concept, soils conditioners-types, characteristics, working principles, significance in agriculture.	
Unit: VII	
Solar and terrestrial radiation measurement, dissipation and distribution in soil crop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infrared thermometer.	
References	
1. Baver, L.D., Gardner, W.H. and Gardner, W.R. 1972. Soil Physics. John Wiley & Sons. 2. Hanks and Ascherof. 1980. Applied Soil Physics. Springer Verlag. 3. Hillel, D. 1980. Applications of Soil Physics. Academic Press. 4. Hillel, D. 1980. Environmental Soil Physics. Academic Press. 5. Indian Society of Soil Science. 2002. Fundamentals of Soil Science. ISSS, New Delhi. 6. Kirkham, D and Powers, W.L. 1972. Advanced Soil Physics. Wiley Interscience. 7. Lal, R. and Shukla, M.K. 2004. Principles of Soil Physics. Marcel Dekker. 8. Oswal, M.C. 1994. Soil Physics. Oxford & IBH.	
Recommended by the Board of Studies	02.02.2024
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Course Code	Modern Concept in Soil Fertility	L	T	P	C
23AG3132		2	0	0	2
Course Objectives:					
Enable the students to - Understand modern concepts of nutrient availability and nutrient response functions. - Gain knowledge on the concepts of chemical equilibria and fertilizer evaluation. - Learn the physical, chemical and biological changes in soils in relation to crop production and fertilizer use.					
Course Outcomes:					
The students will be able to - Describe the concepts of nutrient availability and nutrient response functions. - Explain the models for transformation and movement of essential nutrients in soils.					

3. Discuss on the concepts of Chemical equilibria and kinetic studies of nutrients in soils. 4. Appraise on the modern concepts of fertilizer evaluation. 5. Monitor the physical, chemical and biological changes in soils. 6. Relate carbon sequestration to sustenance of soil quality and crop productivity.	
Theory	
Unit: I	
Nutrient availability-concept and relationships, modern concepts of nutrients availability; soil colloids and nutrient availability; soil amendments and availability maintenance of nutrients, soil solution and plant growth; nutrient response functions and availability indices.	
Unit: II	
Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.	
Unit: III	
Chemical equilibria (including solid-solution equilibria) involving nutrient ions in soils, particularly in submerged soils; Kinetic studies of nutrients in soils.	
Unit: IV	
Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.	
Unit: V	
Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.	
Unit: VI	
Monitoring physical, chemical and biological changes in soils; permanent manurial, trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.	
Unit: VII	
Carbon– a nutrient central to soil fertility; carbon cycle in nature, stocks, pools and fluxes; greenhouse effect and climate change; carbon sequestration vis-à-vis sustenance of soil quality and crop productivity.	
References	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Physical Chemistry of Soil	L	T	P	C
23AG3133		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand colloidal chemistry and cation exchange equilibria.					
2. Learn the thermodynamics of nutrient transformations.					
3. Know the Adsorption/ Desorption isotherms and electrochemical properties of clays.					
Course Outcomes:					
The students will be able to					
1. Apply the modern concepts of physical chemistry of soils for improved nutrient use efficiency.					
2. Explain the chemistry of soil colloids and clay organic interaction.					
3. Elucidate the thermodynamics of nutrient transformations in soils with respect to CEC and AEC.					
4. Identify and manage nutrient fixation in soils in relation to physico- chemical properties.					
5. Work and demonstrate cationic and anionic exchange models.					
6. Infer and apply the utility of adsorption / desorption isotherms in agricultural system.					
Theory					
Unit: I					
Colloidal chemistry of inorganic and organic components of soils—their formation, clay organic interaction.					
Unit: II					
Predictive approaches for cation exchange equilibria- thermodynamics, empirical, and diffuse double layer theory (DDL)- relationships among different selectivity coefficients; structure and properties of diffuse double layer.					
Unit: III					
Thermodynamics of nutrient transformations in soils; Climate change effects on mineralogy and surface properties of variable charge; cationic and anionic exchange and their models, molecular interaction.					
Unit: IV					
Adsorption/desorption isotherms-Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).					
Unit: V					
Common solubility equilibria-carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).					
References					
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2. Bolt, G.H. and Bruggenwert, M.G.M. 1978. Soil Chemistry. Elsevier.					
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Soil Genesis and Micromorphology	L	T	P	C
23AG3134		2	0	0	2

Course Objectives:
Enable the students to

1. Learn the pedogenic evolution of soils, factors and processes involving in the soil formation.
2. Understand the stability and sequences of mineral weathering that contribute to the formation and development of soil profiles.
3. Identify the micro-pedological features and their significance in soil genesis and classification.

Course Outcomes:
The students will be able to

1. Comprehend Pedogenic Evolution.
2. Evaluate Soil Composition and Characters.
3. Analyze the various factors and pedogenic processes are involved in soil formation.
4. Explain the Stability and weathering sequences of minerals.
5. Assess soil profile development through both mineralogical and chemical analysis.
6. Examine the micro-pedological features of soils and their role in soil genesis and classification.

Theory
Unit: I

Pedogenic evolution of soils; soil composition and characterization.

Unit: II

Weathering and soil formation–factors and pedogenic processes; stability and weathering sequences of minerals.

Unit: III

Assessment of soil profile development by mineralogical and chemical analysis.

Unit: IV

Micro-pedological features of soils–their structure, fabric analysis, role in genesis and classification.

References

1. Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
2. Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.
3. Dixon JB and Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
4. Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
5. Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Biochemistry of Soil Organic Matter	L	T	P	C
23AG3136		2	0	0	2

Course Objectives:
Enable the students to

1. Understand the significance of organic matter in soil productivity and its role in enhancing soil fertility and sustainable agriculture practices.

2. Know the biochemistry of humus formation, various pathways of humus synthesis in soils. 3. Relate the transformation of essential nutrients, chelation process and interactions humic substances in soil systems.	
Course Outcomes:	
The students will be able to 1. Comprehend the importance organic matter in soils and its role in soil productivity. 2. Demonstrate carbon retention and sequestration processes in soils. 3. Assess biochemistry of humus formation and explore different pathways for humus synthesis in soil. 4. Evaluate the Nutrient Transformations and Trace Metal Interactions with humic substances. 5. Analyse the Reactive Functional Groups and Clay-Organic Matter Complexes. 6. Comprehend the interactions between humus and pesticides in soils.	
Theory	
Unit: I	
Organic matter in soils and its maintenance Role of organic matter in soil productivity; humus levels in soils; current thinking on the maintenance of organic matter in the soils. Carbon retention and sequestration	
Unit: II	
Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.	
Unit: III	
Nutrient transformation–N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.	
Unit: IV	
Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay organic matter complexes.	
Unit: V	
Humus-pesticide interactions in soil, mechanisms.	
References 1. Lynch JM, Willey JM. <i>Soil Biotechnology</i>. 2. Paul EA and Clark FE. <i>Soil Microbiology and Biochemistry</i> 3. Sherwood LM and Woolverton CJ. <i>Prescott's Microbiology</i>. Subba Rao NS. <i>Advances In Agricultural Microbiology</i>	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Modelling of Soil Plant System	L	T	P	C
23AG3138		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand the concepts, methodology, technology of soil-plant modelling Techniques.					
2. Gain knowledge on the computer languages and numerical techniques used in developing models					
3. Evaluate, simulate, and incorporate the relevant models for yield and nutrient forecasts					
Course Outcomes:					
The students will be able to					
1. Elucidate the soil-crop models.					
2. Forecast the computer and numerical language that was used to create the models.					
3. Execute different types of soil-crop models.					
4. Assess the models and to analyse the data.					
5. Suggest new strategies to improve the soil and plant health using soil-crop models.					
6. Program new models using high level computer language.					
Theory					
Unit: I					

Introduction, terms and definitions; classification of models; Taylor series; numerical methods of differentiation and integration.	
Unit: II	
High level computer language: FORTRAN-its commands and usage; testing and evaluation of model.	
Unit: III	
Description of spatially homogeneous models; K transformation model; nitrogen and phosphorus dynamics in soil.	
Unit: IV	
Spatially heterogeneous models; equation of continuity; Simulation of water flow through soil; Explicit and Explicit-Implicit method; simulation of solute movement through soil with variable moisture flux by explicit-implicit method.	
Unit: V	
Nutrient uptake model: Integration of nutrient movement in soil (mass flow and diffusion) and uptake by plants (Michaelis-Menten kinetics); Nutrient uptake model: Solubility and free ion activity model.	
References	
1. Datta SC. 2008. Theory and Principles of Simulation Modeling in Soil-Plant System. Capital Publishing Company, New Delhi. 2. Frame J and Thornley JHM. 1984. Mathematical Models in Agriculture—A 3. Quantitative approach to problems in agriculture and related science. Butterworth and Co. Ltd. 4. Freud PJ and Minton PD. 1979. Regression Methods—A tool for data Analysis. Marcel Dekker, Inc., New York. 5. Frissel MJ and Reinger P. 1974. Simulation of Accumulation and Leaching in 6. Sils. Oxford and IBM Pub. Co., New Delhi. 7. Hanks J and Richie JT. (Eds.). 1991. Modelling Plant and Soil System. Agronomy, Bulletin No. 31, ASA, SSSA Madison, Wisconsin, USA. 8. Lipschutz S and Poe A. 1978. Schaum's Outline Series—Theory and Problems of programming with Fortran. McGraw-Hill Book Co., Singapore. 9. Penning de Vries FWT, Jansen DM, Ten Berge HFM and Baker A. 1989. 10. Simulation of eco-physiological processes of growth in several annual crops. PUDOC, Wageningen. 11. Shaffer MJ, Ma L and Hansen S. 2001. Modeling Carbon and Nitrogen Dynamics, for Soil Management. Lewis Publishers, Boca Raton	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Soil Resource Management	L	T	P	C
23AG3137		3	0	0	3
Course Objectives:					
Enable the students to 1. Categorize the soil resources, their classification and significance 2. Conceptualize the sustainable land-water management techniques 3. Associate novel technologies in soil resource management					
Course Outcomes:					
The students will be able to 1. Determine the types of soil resources their origin, classification and significance 2. Comprehend and conceptualise the significance of soil quality 3. Identify and describe the problems associated with soil resources 4. Recommend strategies for overcoming problems 5. Build the land-watershed management plans 6. Develop novel technologies for managing soil resources					
Theory					
Unit: I					

Relevance of soil management to sustainable agriculture; soil as a natural resource for biomass production, filtering, buffering, transportation of solutes, gene reserves, and geogenic source of raw materials; soil as a source and sink of greenhouse gases

Unit: II

Concept of sustainable land management (SLM); spatial variability of soils; soil quality and food security; soil quality indices, conservation agriculture in relation to soil quality; soil resilience and resistance.

Unit: III

Types, factors and causes of land degradation and desertification; GLASOD classification; application of GIS and remote sensing in monitoring, diagnosis and mapping land degradation; history, distribution, identification and description of soil erosion problems in India; forms of soil erosion; impact of soil erosion-on-site and off-site effects; strategies for erosion control and conservation; soil conservation in hilly, arid, semiarid, coastal and diaralands. Management of forest, peat and muck soils.

Unit: IV

Soil conservation planning; land capability classification; soil conservation in special problem are as such as hilly, arid and semi-arid regions, waterlogged and wetlands; land restoration and conservation techniques—erosion control, reclamation of salt affected soils; mine land reclamation, afforestation, organic products, soil fauna and biodegradation.

Unit: V

Watershed management-concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds.

Unit: VI

Agro-ecological regions of India; potentials and constraints of soils of different regions; land evaluation and rationalizing land use, decision support system with relation to land management; national and international soil policy considerations.

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2. Andriess JP. 1988. *Nature and Management of Tropical Peat Soils*, Soil Resources, FAO Soils Bulletin 59, Management and Conservation Service, Land and Water Development Division, FAO, Rome
3. Blackwell, Dent D and Young A. 1981. *Soil Survey and Land Evaluation*. George Allen and Unwin, London.
4. Burrough A and McDonnell RK. 1998. *Principles of Geographical Information System*. Oxford University Press.
5. Dan Binkley D and Fisher R. 2012. *Ecology and Management of Forest Soils*, 4th Edition, Wiley.
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Clay Mineralogy	L	T	P	C
23AG3135		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the concepts of clay minerals and crystallography and crystallographic notations.					
2. Elaborate the Occurrence, formation, and transformations of minerals, their influence on soil properties.					
3. Evaluate role of clay minerals in different soil orders and their impact on soil fertility management.					
Course Outcomes:					
The students will be able to					
1. Comprehend Clay mineral Crystallography.					
2. Evaluate Silicate minerals properties and types.					
3. Comprehend Interstratification of clay minerals.					
4. Explain the genesis and transformation of clay minerals.					
5. Assess the surface chemistry of clay minerals.					
6. Demonstrate the role of clay minerals in soil fertility management.					
Theory					
Unit: I					
Definition and concepts of clays and clay minerals, Fundamentals of crystallography – unit cell, external characteristics of crystals, crystallographic notations, crystal systems.					
Unit: II					
Structures and classification of silicate minerals, basics of phyllosilicates, laws governing structural characteristics of phyllosilicates, Goldschmidt’s laws – Laws I and Law II, Classification of Phyllosilicates.					
Unit: III					
Kaolinite group of minerals, Dioctahedral kaolins and Trioctahedral kaolins.					
Unit: IV					
Smectites; properties of smectites, Reference models of structure, principal types based on Hofmann-Marshall Hendricks (H-M-H) models, occurrence of smectites, transformation and formation in soils.					
Unit: V					
Micas: occurrence and origin in soils, polytypes of micas, structure and formation of muscovites and illite.					
Unit: VI					
Vermiculites: structure, occurrence in soils, formation, relation between vermiculites and montmorillonite.					
Unit: VII					
Chlorite: occurrence and structure of chlorites, “swelling chlorites”, formation of chlorite.					
Unit: VIII					
Non-crystalline clays (amorphous materials), subgroups and chemical composition, morphology and structure, physico-chemical properties, influence of non-crystalline clays on soil properties.					
Unit: IX					
Interstratified clay minerals, occurrence and formation in soils, regularly interstratified and partially random interstratified minerals.					
Unit: X					

Genesis and transformation of clay minerals, Generalized conditions for formation and persistence of common clay-size minerals in soils.	
Unit: XI	
Surface chemistry of clay minerals, clay-organic complexes, nanoclay mineralogy.	
Unit: XII	
Clay minerals in different soil orders, role of clay minerals in soil fertility management.	
Practical	
Separation of clay for mineralogical study, X-ray diffraction analysis of clay, Selective dissolution of clay minerals, IR, DTA and SEM of clay minerals, Identification and quantification of clay minerals, Determination of surface charge of clay minerals, Potentiometric titration of clay minerals.	
References	
1. Dixon JB and Weed SB (Co-editors). <i>Minerals in Soil Environment</i>. 2. Gieseking JE (Ed). <i>Soil Component</i>, Vol. 2. Inorganic Components. 3. Grim RE. <i>Clay Mineralogy</i>. 4. Mukherjee SK and Biswas TD (Editors). <i>Mineralogy of Soil Clays and Clay Minerals</i>. Read HH. <i>Rutley's Elements of Mineralogy</i>. 5. Wilding LP and Smeck NE. 1983. <i>Pedogenesis and Soil Taxonomy Part II – Soil Orders</i>.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Recent Trends in Soil Microbial Biodiversity	L	T	P	C
23AG3139		2	0	1	3
Course Objectives:					
Enable the students to 1. Understand the microbial biodiversity their beneficial and harmful effects. 2. Study the interaction between microbial organisms-soils-crops. 3. Gain knowledge on the molecular approaches in detection and characterization of different soil microorganisms.					
Course Outcomes:					
The students will be able to 1. Categorize the microbial diversity in soils 2. Examine the functions and characters of soil microorganism 3. Present the interaction effects of microorganisms on soil-crop 4. Estimate the soil microorganisms, enzyme activity using both classical and molecular approaches 5. Characterize the soil microorganism for solid waste management 6. Exhibit the use of several microbes to illustrate the processes of biodegradation and bioremediation.					
Theory					
Unit: I					
Microbial evaluation and biodiversity, Microbial communities in ecosystems, New insights in below ground diverse of plant performance.					
Unit: II					
Qualitative ecology of microorganisms; Biomass and activities.					
Unit: III					
Nitrogen fixing organisms, Trends in diversity of N fixing organisms. Molecular approaches in characterising N fixing microorganisms.					
Unit: IV					
Serology and molecular characterization, ecological aspects of bio determination, soil waste and water management					
Unit: V					
Biodegradability, testing and monitoring of the bioremediation of xerobiotic pollutants and bacterial fertilizers.					

Practical	
Determination of soil microbes using classical techniques. Determination of soil microbial diversity using molecular techniques. Estimation of soil microbial biomass carbon, nitrogen and phosphorus. Estimation of key soil enzyme activities. Community level physiological profiling of microbial diversity	
References	
1. Lynch JM, Willey JM. Soil Biotechnology. 2. Paul EA and Clark FE. Soil Microbiology and Biochemistry. 3. Sherwood LM and Woolverton CJ. Prescott's Microbiology. 4. Subba Rao NS. Advances In Agricultural Microbiology.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Improvements in Fermentation Technology	L	T	P	C
23AG3160		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the basics of fermentation, metabolic engineering, fermenter design and downstream processing.					
2. Apply the technological advancement of fermentation and bioprocess for industrial applications.					
3. Commercialize microbial products.					
Course Outcomes:					
The students will be able to					
1. Explore diverse microorganisms in the manufacture of bioproducts					
2. Apply industrially useful microorganisms for boosting the bio-economy.					
3. Acquire skills in recombinant strategies and gene expression					
4. Describe the techniques in fermentation and down streaming process					
5. Demonstrate skill in fermenter operation and process optimization					
6. Develop skills to become a bioentrepreneur					
Theory					
Block 1: Rise of Fermentation Technology					
Unit: I: Development in Fermentation					
Definition of fermentation – rise of fermentation technology –current trends in fermentation industry – scope and importance of fermentation technology.					
Unit: II: Types of fermenters					
Continuous, batch and fed batch culture –anaerobic fermentation - range of fermentation process – microbial growth cycle – diauxic growth – growth kinetics – substrate uptake kinetics (Jacob and Monod) - primary and secondary metabolites – future prospects of fermentation microbiology					
Block 2: Fermenter					
Unit: I: Components of fermenter and use					
Peripheral parts and accessories – alternative vessel designs –containment in fermentation – fermenter preparation and use - aeration and agitation – instrumentation and control – biosensors in monitoring – computer applications in fermentation technology					
Block 3: Fermentation Process					
Unit I: Types of Fermentation					
Solid state and submerged fermentation – acidic/alcoholic fermentation – recovery of product – effluent treatment – Economics of fermentation					
Block 4: Recombinant Strategies Followed					
Unit I: Strategies for isolation of industrially important microbes					
New strategies for isolation of industrially important microbes and their genetic manipulations; Antibiotic fermentation research; steroid transformation; Yeast technology – classification, genetics, strain improvement for brewing, baking and distilleries					

Practical

Studying the various components of fermenter - exposure to different types of fermenters - sterilization and operating procedures - designing the production medium- isolation and purification of industrially important microbes- Genetic manipulations in microbes- Fermentation by improved strains of yeast for production of alcohol- microbial production of enzymes by solid state fermentation- Microbial production of important antibiotics Bioremediation of industrial effluents

References

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2. Patel AH. *Industrial Microbiology*
3. ElMansi EMT and Bryce CFA. *Fermentation Microbiology and Biotechnology*
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Websites

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- <http://www.microbiologyonline.org.uk>
- <http://www.microbeworld.org>
- <http://www.scribd.com/doc/46151150/Fermentation-Technology>
- <http://www.chalmers.se/en/areas-of-advance/lifescience/research/Pages/Fermentation-Technology.aspx>

Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Microbial Physiology and Regulation	L	T	P	C
23AG3161		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand the metabolic diversity in microbes.					
2. Gain knowledge on microbial ecology and their adaption mechanisms to various environmental conditions					
3. Relate the microbial metabolism and physiological process					
Course Outcomes:					
The students will be able to					
1. Demonstrate the molecular aspects of various physiological process					
2. Acquire knowledge on the molecular biology of microbes					
3. Apply stress tolerance mechanisms of microbes for climate resilience					
4. Analyze gene regulation and key regulatory pathways					
5. Explore biomolecule synthesis in microorganisms					
6. Update and utilize recent advances in microbial physiology and regulatory genes					
Theory					
Block 1: Historical Evaluation of Microbial Physiology					
Unit: I: Molecular aspects of various cell component					
Origin, evolution, structure, function and molecular aspects of various cell components. Differentiation in bacteria, slime molds, yeasts. Molecular biology of bioluminescence, bacterial virulence. Heat shock response. Extracellular protein secretion in bacteria.					

Block 2: Regulation and Pathways	
Unit: I: Regulatory Pathways	
Regulation of initiation, termination and anti-termination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria - inducible and biosynthetic pathways. Oxidative stress control. Fermentative and respiratory regulatory pathways	
Unit: II: Regulatory control	
Ribosomal RNA and ribosomal proteins regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense RNA regulation of gene expression. Biosynthesis of micromolecules (Nucleotides and Aminoacids) macromolecules (DNA, RNA, Proteins) Global nitrogen control and regulation of nitrogen fixation	
Unit III: Current topics	
Topics of current interest in Molecular microbiology and regulatory systems.	
References	
Websites	
• https://www.frontiersin.org/journals/microbiology/sections/microbial-physiology-andmetabolism • https://www.sciencedirect.com/bookseries/advances-in-microbial-physiology • https://www.researchgate.net/journal/0065-2911_Advances_in_Microbial_Physiology • https://bmb.psu.edu/undergraduate/courses/course-archive/2016/fall-2016/microbiologymicrb/micrb-401-fall-2016/micrb-401-microbial-physiology-and-structure	
Selected articles from journals.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Recent Developments in Soil Microbiology	L	T	P	C
23AG3162		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand the bioconversion of organic matter into simple organic substances.					
2. Learn the role of microorganisms in maintaining life on earth					
3. Gain knowledge on Ecology and microbial diversity					
Course Outcomes:					
The students will be able to					
1. Describe molecular ecology and diversity of soil microbes					
2. Assess the interaction between chemicals-pollutants-microbes in the soil					
3. Familiarize with microbes involved in bioconversion					
4. Demonstrate the role of microbes in maintaining soil health and quality					
5. Apply microbial indicators to asses soil fertility					
6. Utilize microbes in bioremediation and biological control					
Theory					
Block 1: Recent Developments in Soil Microbiology					
Unit: I: Ecology and microorganisms’ diversity					
Molecular ecology and biodiversity of soil microorganisms; Survival and dispersal of microorganisms. Interaction between agricultural chemicals, pollutants and soil microorganism					
Unit: II: Role of microorganisms in soil					
successions and transformation of organic matter; Role of microorganisms in soil fertility. Soil health and quality: Microbial indicators					
Unit: III: Bioremediation					
Bioremediation of polluted soils; Biological control. Other topics of current interest					

References
Websites

- <https://www.springer.com/in/book/9789811073793>
- https://www.researchgate.net/publication/322952969_Advances_in_Soil_Microbiology_Recent_Trends_and_Future_Prospects_Volume_2_Soil-Microbe-Plant_Interaction
- Selected articles from journals.

Recommended by the Board of Studies	02.02.2024
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Course Code	Recent Approaches in Environmental Microbiology	L	T	P	C
23AG3163		2	0	0	2
Course Objectives:					
Enable the students to 1. Understand the microbial activities at large in nature/environment. 2. Evaluate the role of microbes in providing ecosystem services. 3. Gain knowledge on microbial waste treatment and harnessing energy.					
Course Outcomes:					
The students will be able to 1. Assess the various environmental issues. 2. Formulate methods for sustainable environmental management. 3. Demonstrate the process of microbial waste treatment. 4. Evaluate renewable sources of energy. 5. Apply microbes for harnessing energy. 6. Develop safe waste disposal strategy to solve global environmental problems.					
Theory					
Block 1: Recent Environmental Issue					
Unit: I: Basic concept and environmental issues					
Types of environmental pollution; problems arising from high-input agricultural residues. Air and water pollution.					
Unit: II: Methodology of environmental management					
Waste water treatment -physical, chemical, biological and microbial processes; need for water and natural resource.					
Unit: III: Microbial waste treatment					
Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, detergents, etc.; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc.); anaerobic processes: digestion, filtration, etc.					
Block 2: Energy Harnessing from Organic Waste					
Unit I: Pollution through conventional fuel					
Conventional fuels and their environmental impact					
Unit II: Renewable sources of energy					
Energy from solid waste; ; biogas; land filling, microbial hydrogen production; use of agro industrial waste, agricultural waste for sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.					
Block 3: Treatment of Waste for Safe Disposal					
Unit I: Disposal of domestic and industrial wastes					
Treatment schemes of domestic waste and industrial effluents; food, feed and energy, from solid waste; bioleaching; enrichment of ores by micro-organisms.					
Unit II: Global environmental problems					
Ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; Microbial and biotechnological approaches for the management of environmental problems.					

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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Plant Microbe Interactions	L	T	P	C
23AG3164		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the interactions between plant and microbes.					
2. Gain knowledge on plant defense systems and stress responses.					
3. Learn the molecular mechanisms underlying plant-microbe interactions.					
Course Outcomes:					
The students will be able to					
1. Differentiate the ecosystem types and interfaces of interactions.					
2. Explore the signaling mechanisms involved in plant-microbe interaction.					
3. Familiarize advanced techniques in genomics and proteomics.					
4. Analyze the defense mechanisms and the molecular cascades.					
5. Utilize the biomolecules secreted by the plant root as well as microbes.					
6. Apply plant-microbe interactions for soil and plant health for sustaining crop productivity.					
Theory					
Block 1: Types of Ecosystems and Microbial Interaction					
Unit: I: Different interfaces of interactions					
Plant-microbe, microbe-microbe, soil- microbe, soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal, <i>Azolla-Anabaena</i>), associative, endophytic and pathogenic interactions.					
Unit: II: Ecosystem- Concept and Dynamics					
Types of ecosystems: Concept and dynamics of ecosystem, Food chain and energy flow, Microbial communities in the soil. Community dynamics and population interactions employing DGGE, TGGE, T-RFLP.					
Block 2: Signalling and Interaction among Microbes					
Unit: I: Microbial interaction					
Quorum-sensing in bacteria, flow of signals in response to different carbon or other substrates and how signals are recognized.					
Block 3: Genomic and Proteomic Study in Plant Microbe Interaction					
Unit I: Methodology/resources in plant-microbe interaction					
Methodology/resources to study plant-microbe interaction, biosensors, transcriptome profiling, metabolic profiling, genomics, and proteomics Induced systemic resistance against pathogens and tolerance against abiotic stress: Molecular basis; Molecular diversity of microbes, plants and their interactions including transgenic microbes and plants					
Practical					
Phylochip based microbial community analyses- Endophytic and phyllosphere microbial community- PCR-DGGE-Rhizosecretion - secretome -FT-IR, HPLC- Multifunctional protein identification and characteriation-2DE, MALDI-TOF- Examination of mycorrhizal infection in roots of different plants- Characterization of PGPR; Quantification of siderophores, HCN and IAA					
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Journals

1. Advances in Microbial Physiology
2. Annual Review of Genetics/Biochemistry
3. Annual Review of Microbiology
4. Applied and Environmental Microbiology
5. Biology and Fertility Soils
6. Indian Journal of Microbiology
7. Journal of Bacteriology
8. Journal of Basic Microbiology
9. Microbiology and Molecular Biology Reviews
10. Nature/Science/EMBO Journal
11. Reviews in Microbiology and Biotechnology
12. Soil Biology and Biochemistry
13. Trends in Biotechnology
14. Trends in Microbiology
15. Trends in Plant Sciences

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9. <http://www.microbeworld.org/resources/links.aspx>
10. <http://www.asm.org/>
11. <http://www.microbiologyworld.com/>
12. <http://www.sciencemag.org/cgi/collection>
13. <http://www.latrobe.edu.au/microbiology/links>
14. www.uwstout.edu/lib/subjects/microbi
15. <http://www.aemtek.com>

Journal related to Microbiology

1. <http://www.fems-microbiology.org/website/nl/default.asp>
2. <http://www.blackwellpublishing.com/journal>

3. http://www.springer.com/	
4. http://www.e-journals.org/microbiology/	
5. http://pubs.nrc-cnrc.gc.ca/	
6. http://www.elsevier.com/	
7. http://www.academicjournals.org/ajmr/	
8. http://www.horizonpress.com/gateway/journals.html	
9. http://www.scielo.br/bjm	
10. http://www.jmb.or.kr/	
11. http://microbiologybytes.wordpress.com/	
http://www.topix.net/science/microbiolog	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Functional Genomics and Genes Associated with Few	L	T	P	C
23AG3166	Physiological Processes	2	0	0	2
Course Objectives:					
Enable the students to					
1. Gain knowledge on functional genes regulating physiological process 2. Utilize the Genomic approaches for validation of functional genes 3. Understand synthetic biology and interaction of various omics approaches					
Course Outcomes:					
The students will be able to					
1. Update and make use of the recent advances in gene expression. 2. Unravel the genetic tools in plant development. 3. Describe the concepts of gene-knock outs. 4. Exercise different gene validation techniques 5. Engineer microbial pathways in plants. 6. Explore the regulatory mechanisms of genes influencing physiological process.					
Theory					
Block 1: Functional Genomics And Genes: Physiological Processes					
Unit: I: Gene Discovery					
Finding genes in complex plant system, Constructing gene-enriched plant genomic libraries, Recent advancements in genome sequencing, RNA sequencing and expression, In Silico prediction of plant gene function, Quantitative Trait Locus analysis as a gene discovery tool, Gene expression analysis –micro-array and deep sequencing, small RNA and Degradome, Study of methylome and its significance					
Unit: II: Genetic Tools for Plant Development					
Understanding the importance of mutants in unveiling the physiological processes, genome wide insertional mutagenesis – T-DNA insertion mutants, Gain in function, Transposon mutagens, Transposition, Physical and Chemical mutagenesis, Gene and Enhancer Traps for Gene Discovery, High-Throughput TAIL-PCR as a Tool to identify DNA Flanking insertions, High-Throughput TILLING for functional Genomics, Genome editing approaches for functional analysis of genes.					
Unit: III: Gene Knock Out Approaches					
PTGS-Antisense technology, Virus induced gene silencing (VIGS), Custom Knockouts with Haripin RNA-mediated Gene Silencing and other silencing tools, Complementation studies.					
Unit IV: Chemical Genomics					
Reverse chemical genomic approaches for functional validation of genes, Protein structure prediction, homology modelling and virtual screening by using bioinformatic approaches to identify the small molecules and their validation through phenotyping assessment.					
Unit V: Gene Over Expression Approaches					
Vector Construction for Gene Overexpression as a Tool to Elucidate Gene Function Transient expression, Transgenics, Targeted and conditional expression of transgene. Multiple gene expression					

by Nanostring technology, Co-expression analysis and gene networking to identify potential genes in the pathway (informatics), Epigenetics.

Unit VI: Synthetic Biology and Interaction Studies

Engineering microbial pathways in plants (eg, photosynthesis), DNA-protein & Protein-protein interaction studies, yeast hybrid system, Correlating the data from genome, transcriptome, proteome, metabolome and ionome with phenome, Multivariate analysis and identification of metabolite as biomarkers.

Unit VII: Case Studies

Functional characterization of genes associated with important cellular processes influencing crop growth and development: genes controlling photosynthesis and nutrient uptake, Functional characterization of genes associated with important cellular processes influencing crop growth and development: genes controlling respiration and photorespiration, Functional characterization of genes associated with important cellular processes influencing crop growth and development: fatty acid biosynthesis, seed protein quality and quantity, Functional characterization of genes associated with important cellular processes influencing crop growth and development: genes controlling flowering.

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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Plant Phenomics-Next Generation Phenomics Platforms	L	T	P	C
23AG3167		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand the cutting-edge approaches in plant phenotyping techniques.					
2. Learn the principles in various phenotyping techniques.					
3. Gain knowledge on recent developments in Phenomics platform.					
Course Outcomes:					
The students will be able to					
1. Demonstrate the principles of phenotyping techniques.					
2. Practice phenotypic approaches for trait diversity.					
3. Explore the trends and features in phenomics platform.					
4. Design phenomics platform and imaging tools.					
5. Apply phenotyping techniques to asses crop responses.					
6. Specialize in the field of crop phenomics.					
Theory					
Block 1: Concepts of High throughput Phenotyping and its Requirement					
Unit: I: Concepts of Phenotyping					
The concepts of “phene and trait” analogous to gene and allele. Genome-phenome relationship, definition of phenotyping, GxE interaction on phenome.					
Unit: II: Physio-Morphological Traits Associated with Crop Performance					
Overview of phenotyping needs to complement genomic resources, specific traits associated with yield potential, stress adaptation (both biotic and abiotic stresses). Need for high throughput precision phenotyping approaches for basic studies and to generate genetic and genomic resources					
Unit: III: Features of Phenomics Platforms					
Precision growth conditions, maintenance of light, temperature/VPD and RH to realize the potential crop growth response, Controlled environmental facilities for simulating challenging climatic conditions to phenotype diverse plant traits, Concept of sensors, diverse sensors and their utility in precise quantification of environmental variables, soil moisture sensors, Imaging to capture plant traits, image acquisition. Automated big data access, processing, etc.					
Unit IV: Trends in Phenomics					
Types of phenomic platforms- Laboratory, Greenhouse and the field-based platforms. Platforms designed for specific needs i.e., root phenotyping, drought studies etc., Crop specific phenotyping, mobile and stationary platforms, Global trends in establishing major phenomics platforms, and their characteristic features and impact.					
Unit V: Non-invasive Phenotyping Approaches					
The concept of non-invasive capturing of plant growth and health, Imaging technologies - image acquisition, segmentation and data analysis, Critical aspects of Visual, IR Thermal, Fluorescence, NIR, Hyperspectral imaging, Development and validation of models for deriving relevant physiological traits from image phenome. Concepts of Plants to sensors and sensors to plants, Stationary and ground-based tractor mounted sensors/imaging tools, Unmanned aerial vehicle (UAV) sensors, Machine learning and its integration to analyze ground and aerial based images.					
Block 2: Applications of the Phenomics Platforms					
Unit I: Basic Studies to Assess the Crop Response					

Functional validation of genes, chemicals and other interventions, Characterize the growth and stress response in contrasts to identify the relevance of adaptive trait.

Unit II: Applied Studies Focused on Crop Improvement Programs

Characterizing the pre-released promising lines for productivity under defined environmental variables. Phenotyping germplasm accessions, mapping populations for specific traits for mapping, Concept of Phenome Wide Association Studies (PWAS). Genomic selection, gene-based crop models to predict complex traits, Impact of phenomics platform, progress made, case studies.

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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Advanced Micro Economic Analysis	L	T	P	C
24AG3170		1	0	1	2
Course Objectives:					
Enable the students to 1. Understand the fundamental theories of consumer behaviour and models of microeconomics; 2. Acquire knowledge on welfare theories in relation to concepts of general equilibrium and allocative efficiency. 3. Defend government intervention in the context of knowledge asymmetries, externalities, and public goods.					
Course Outcomes:					
The students will be able to 1. Explain the fundamental concepts of consumer and producer behaviour and mathematical models of microeconomics. 2. Work out strategies for attaining equilibrium in the market. 3. Understand the different market competition, shortcomings of markets and comprehend how they function					

4. Compute and derive the cost/profit function, consumer surplus, and demand functions. 5. Justify the widespread application of market procedures in economic transactions. 6. Gain knowledge on approaches and limitations on social welfare	
Theory	
Block 1: Consumer Theory	
Unit: I: Consumer Theory	
Theory of consumer behavior – Duality in consumer theory - expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions – Integrability of demand functions. Demand Models – Linear Expenditure System, Almost Ideal Demand System. Applications of consumer theory – Household model and time allocation – Labour supply decisions by households.	
Block 2: Market and General Equilibrium	
Unit: I: Market	
Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly - Cournot model, Chamberlin model, Stackleberg solution.	
Unit: II: General Equilibrium	
General equilibrium theory – Conceptual overview - General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.	
Block 3: Market Failure and Welfare	
Unit I: Market Failure	
Market failure Market failure - Incomplete markets - Asymmetric information – Principal-Agent problem, adverse selection and moral hazard. Externalities – Network externalities, Public goods – Optimal provision of public goods	
Unit II: Welfare Economics	
Welfare Economics Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare – Criteria for social welfare - Social Welfare functions, Social versus Private costs and benefits.	
Practical	
Problems in consumer utility maximization Estimation of income and substitution effects; Estimation and comparison of Consumer's surplus, equivalent variation and compensating variation. Estimation of demand models – Derivation and estimation of labour supply equations from household models comparative static analysis in consumption. Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition. Game theory models. Problems solving in General Equilibrium Theory and Welfare Economics. Problems in public goods provision.	
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Advanced Macro Economic Analysis	L	T	P	C
24AG3171		2	0	0	2
Course Objectives:					
Enable the students to					
1. Elucidate and discuss about advanced macroeconomic theory.					
2. Understand the functioning of national economy, its history and models					

3. Describe the monetary rules, inflation targeting, the conceptual foundations of central bank usage of them, and the effects of implementing varied monetary policies.	
Course Outcomes:	
The students will be able to 1. Understand the rationale behind the working of different economy 2. Figure out how policies are framed to safe guard the national economy 3. Know the fundamental concepts of short-run macroeconomic theory. 4. Analyse how macroeconomic policy might increase economic wellbeing by using macroeconomic theory 5. Discover how to apply important methodological techniques in contemporary dynamic macroeconomics. 6. Analyze and evaluate the most fundamental macroeconomic models of employment	
Theory	
Block 1: Introduction	
Unit: I: Overview	
Conceptual framework - Classical, Keynesian, Neo-Classical, and Neo-Keynesian macroeconomics; Review of Keynes-Classical Synthesis; Aggregate Demand and Supply in the closed economy with fixed and variable price level- determination of wage, prices, output and employment	
Block 2: Economic Models	
Unit: I: Open Economy Models	
Exchange rate determination; purchasing power parity; asset market approach; Short-run open economy models; Mundell-Fleming model- exchange rate regime: perfect capital mobility under fixed and flexible exchange rate; effectiveness of fiscal policy and monetary policy; Dornbusch's overshooting model; monetary approach to balance of payments; international financial markets	
Unit: II: Dynamic Macroeconomic Models	
Introduction to dynamic macroeconomic Models; Dynamic aggregate demand and supply – short- and long-term equilibrium- rational expectations approach	
Block 3: Business Cycle and Policies	
Unit I: Business Cycles	
Business cycle and its alternative equilibrium model, Stability analysis Economics of Great Events- Depression, Hyperinflation and Deficits; Advances in Business Cycle Theory; Real Business Cycles & Neo-Keynesian Economics	
Unit II: Macroeconomic Polices	
Monetary policy - Design of Monetary Policy; Inflation Targeting, Fiscal Policy - Government Budget Constraint: The Arithmetic of Deficits and Debt, Current versus Future Taxes, the Evolution of Debt-to-GDP Ratio; Public Borrowing-Internal and external aid, Deficit financing, Development Financing; BOP & Adjustment Policies - Foreign Exchange Policy -International macro-economic policies, IMF, IBRD, UNCTAD	
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Recommended by the Board of Studies	02.02.2024
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Course Code	Advanced Econometrics	L	T	P	C
24AG3172		2	0	1	3
Course Objectives:					
Enable the students to					
1. Provide a strong foundation in econometrics and statistics to conduct data analysis in economics					
2. An exposure to various theories of Statistics and Econometrics, along with a demonstration of their applications.					
3. To introduce students to use of statistical software for data analysis.					
Course Outcomes:					
The students will be able to					
1. Define OLS, IV and maximum likelihood estimators mathematically.					
2. Formulate and experiment with different econometric models					
3. Analyse the data collected for testing the framed hypothesis.					
4. Get expertise in analytical framework.					
5. Exhibit an awareness of the strength and drawbacks of the different estimators					
6. Work with large-scale data sets with ease be encouraged to develop independent research interests and applied research projects					
Theory					
Block 1: Concepts					
Unit: I: Review					
Review of classical regression model – review of hypothesis testing – restrictions on parameters – single equation techniques.					
Block 2: Least Squares and Dummy Variables					
Unit: I: Concept of least squares					
Ordinary least squares – weighted least squares - generalized least squares – method of principal components – instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests – non spherical error terms.					
Unit: II: Dummy Variable					
Dummy variables - Qualitative and truncated dependent variables - limited dependent variables – LPM, probit and logit models, their multinomial extensions.					
Block 3: Econometric Models					
Unit I: Models and their extensions					
Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.					
Unit II: Simultaneous equation models					
Simultaneous equation models Simultaneous equation methods –identification – estimation by indirect least squares 2SLS, PIML, SURE, 3SLS					
Practical					
Estimation of multiple regression model - GLS estimation methods - testing misspecification errors – Testing and Managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, Logit and Probit models - comparing two regressions - Chow test - estimation of distributed lag models – panel data random and fixed effects models - Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models					
References					
1. Greene WH. 2002. Econometric Analysis. Pearson Education.					
2. Johnston J and Dinardo J. 2000. Econometric Methods. Mc Graw-Hill.					
3. Koutseyianis A. 1997. Theory of Econometrics. Barner & Noble.					
Recommended by the Board of Studies		02.02.2024			
Approved by the Academic Council		11.05.2024			

Course Code	Advanced Production Economics	L	T	P	C
24AG3173		2	0	1	3
Course Objectives:					
Enable the students to					
1. Develop the understanding of advanced production process and the guiding economic principle for agricultural production;					
2. Apply the appropriate cost concepts and economic models under different production scenario to optimize the production process.					
3. Learn about risk and uncertainty in agricultural production and apply the appropriate economic models to overcome risk in agriculture					
Course Outcomes:					
The students will be able to					
1. Gain knowledge on advanced production economics principles and their applications					
2. Acquire necessary theoretical and analytical skills to optimise the agricultural production					
3. Get familiar with different production function and use them in practise and come out with useful decision.					
4. Work out the efficiency of the production process and use models for finding the optimum solution					
5. Get trained in production economics tools for agricultural decision making and policy analysis					
6. Develop expertise in applying production economics principles and models to approach the empirical problems and issues					
Theory					
Block 1: Production Process					
Unit: I: Production Process					
Agricultural Production process – Relationship between farm planning and production economics- scope of agricultural production and planning-methods/ procedures in agro-economic research and planning					
Block 2: Production Function					
Unit: I: Production Functions and Characteristics					
Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity,, APP, MPP, elasticities of substitution and their economic relevance – Production relations – optimality Commonly used functional forms, nature, properties, limitations, estimation and interpretation - linear, Spillman - Cobb Douglas, quadratic, multiplicative (power) functional forms - Translog, and transcendental functional forms - CES, production functional forms-Conceptual and empirical issues in specification, estimation and application of production functions- Analytical approaches to economic optimum - Economic optimum – determination of economic optimum with constant and varying input and output prices - Economic optimum with production function analysis - input use behaviour.					
Block 3: Dynamics of Production Process					
Unit I: Decision Making in Production					
Decision making with multiple inputs and outputs – MRT and product relationship cost of production and adjustment in output prices-single input and multiple product decisions- Multi input, and multi product production decisions - Decision making with no risk -Cost of wrong decisions - Cost curves – Principles and importance of duality theory - Correspondence of production, cost, and profit functions - Principles and derivation of demand and supply functions					
Unit II: Technology, Efficiency and Risk Management					
Technology, input use and factor shares -effect of technology on input used e composition analysis-factor shares-estimation methods- Economic efficiency in agricultural production – technical, allocative and economic efficiency – measurement -Yield gaps analysis – concepts and measurement - Risk and uncertainty in agriculture – incorporation of risk and uncertainty in decision making – risk and uncertainty and input use level-risk programming.					
Unit III: Programming					

Simulation and programming techniques in agricultural production-Multiple Objective Programming (MOP) – Goal programming, Weighted sum and Compromise programming – applications.	
Practical	
Estimation of different forms of production functions- Optimal input and product choice from estimated functions-Derivation of demand and supply functions and estimation-Estimation of cost function and interpretations-Optimal product and input choice under multi input and output system-Estimation of factor shares from empirical functions estimated-Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology. Estimation of efficiency measures – Stochastic, probabilistic and deterministic frontier production functions-Risk programming – MOTAD-Quadratic programming. Simulation models for agricultural production decisions-Goal programming – Weighted, lexicographic and fuzzy goal programming-Compromise programming.	
References	
1. Baumol WG. 1973. Economic theory and operations analysis. Practice Hall of India Private Limited, New Dehli. 626 p. 2. Gardner BL and Rausser GC. 2001. Handbook of Agricultural Economics Vol. I Agricultural Production. Elsevier. 3. Heady EO. 1952. Economics of Agricultural Production and resources use. Practice Hall of India. 4. Heady EO and Dillon JL. 1961. Agricultural Production functions. Kalyani Publishers, Ludhiana, India. 667 pp.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Advanced Agricultural Marketing and Price Analysis	L	T	P	C
24AG3174		2	0	1	3
Course Objectives:					
Enable the students to 1. Acquire knowledge and analytical skills in the field of agricultural marketing 2. Enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities 3. Know the various agricultural commodity price forecasting and analysis principles and models.					
Course Outcomes:					
The students will be able to 1. Comprehend the framework of Indian agriculture marketing, 2. Gain the knowledge of marketing and agricultural prices. 3. Work out the interaction between different markets and analyse their working 4. Gain expertise in forecasting of price and build up market intelligence. 5. Develop capacities and analyse new marketing institution policies 6. Understand price analysis models of agricultural commodities and marketing concepts and strategies.					
Theory					
Block 1: Concepts					
Unit: I: Agricultural Marketing-					
Insights Importance of market analysis in the agricultural system - types of marketing-advantages and disadvantages - quantitative estimation -the distinguishing characteristics and role of agricultural prices -data sources for agricultural products and prices - softwares used in market analysis.					
Block 2: Marketing Institutions and Dynamics					
Unit: I: Institutions and their functions					
Role of various formal institutions in agricultural marketing - and functions - measuring their efficiency - public - private partnership - institutional arrangements. Successful case studies.					
Unit II: Market Dynamics					

Multi market estimation, supply response models. Market integration and price transmission - supply / value chain management. GAP analysis. Current trends in information in the changing agrifood system.

Block 3: Techniques

Unit I: Commodity Marketing

Agricultural commodity marketing -spot and futures- marketing of derivatives- speculation, hedging, swap, arbitrage etc. commodity exchanges - price discovery and risk management in commodity markets-Regulatory mechanism of futures trading

Unit II: Models for Analysis

Lag operators and difference equations; stationary and stochastic processes; Unit roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models-forecast evaluation; methods of forecasting. price indices and econometric estimation and simulation.

Practical

Estimation of demand/ supply forecasting, Supply chain/ value chain analysis for different commodities, Commodity models- multi market estimation- time series analysis, Market integration studies- price discovery price volatility estimation, Commodity price forecasting using econometric softwares.

References

1. Acharya SS and Agarawal NL. 1994. Agricultural Prices-Analysis and Policy. Oxford and IBH Publishing company Pvt. Ltd, New Delhi.
2. Acharya SS and Agarawal NL. 2004. Agricultural Marketing in India. Oxford and IBH Publishing company Pvt. Ltd, New Delhi.
3. Kohls RH and Joseph N. Uhl: Marketing of Agricultural products by Collier MacMillan International.
4. Rhodes VJ. 1978. The Agricultural Marketing System. Grid Pub. Ohio.

Recommended by the Board of Studies 02.02.2024

Approved by the Academic Council 11.05.2024

Course Code	Quantitative Development Policy Analysis	L	T	P	C
24AG3175		1	0	1	2
Course Objectives:					
Enable the students to					
1. Develop expertise in understanding the rationale behind development of policies.					
2. Get the opportunity to conceptualize equilibrium and working out the economic implications of development policy.					
3. Determine appropriate set of tools and techniques to address a particular public policy issue.					
Course Outcomes:					
The students will be able to					
1. Recognize the value of quantitative analysis and conceptualize a policy framework.					
2. Describe the benefits and drawbacks of various analytical and evaluation tools.					
3. Evaluate public policy issues applying demand and supply analysis, operations management strategies, statistical and econometric methodologies.					
4. Demonstrate capacity in utilising key tools for macroeconomic policy analysis such as the CGE and programming models.					
5. Compare and analyze various options for government policy by applying economic welfare approaches					
6. Learn about a variety of economics techniques through the use of advanced statistical software.					
Theory					
Block 1: Concepts					
Unit: I: Policy Framework					

Policy framework – goals, value, beliefs and welfare maximization. Market – Policy and State – State vs. Market – Failure of Policy – Failure of Markets – Rationale for Government Intervention. Role of Quantitative Policy Analysis.	
Block 2: Demand-Supply and Household Behaviour	
Unit I: Demand- Supply Analysis	
Demand analysis for policymaking – Alternative approaches to demand analysis – Policy implications. Supply response – Alternative approaches to measurement of supply response – Nerlovian models of supply response – Policy implications.	
Unit II: Household Behaviour and Models	
Household behaviour and policy analysis – Household models.	
Block 3: Approaches to Review Policy and Welfare	
Unit I: Multi-Pronged Approach to Policy Review	
Partial equilibrium analysis – Concept of reference prices – Price distortions – indicators and impact. Transaction costs – Implications for efficiency and productivity – Institutional solutions - Multi market approach to policy analysis	
Unit II: General Equilibrium and Programming	
Social Accounting Matrices and multipliers – Computable General Equilibrium models to assess economy wide impact of policy changes. fuzzy goal programming- Compromise programming.	
Practical	
Review of criteria for policy evaluation, Estimation of price elasticities, Review of estimation of complete demand systems, Estimation of Nerlovian supply Response model, Review of Household models, Specification and estimation of household models, Partial equilibrium analysis• Input–output table, Social Accounting Matrix, Construction of a SAM, Computation of Multipliers• Multi Market Analysis, Review of Computable General Equilibrium Models.	
References	
1. Kindleberger, P. Charles, “Economic Development” (London :(McGraw Hill International Book Company), 1977 2. Ghatak Subrata and Ken Ingersent, “Agriculture and Economic Development” (New Delhi: Select Book Service Syndicate), 1984. 3. John, and J. Walley (1992), Applied General Equilibrium (New York: Cambridge University Press). 4. Shoven Neck, Reinhard; Christian Richter and Peter Mooslechner, “Quantitative Economic Policy”, Essays in Honour of Andrew Hughes Hallett (Eds), 2008. 5. Fischer Gerald, J. Miller and Mara S. Sidney, eds, Handbook of Public Policy Analysis: Theory, Politics and Methods (Boca Raton, Fla.: CRC Press, 2007).	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Natural Resource Management	L	T	P	C
24AG3176		2	0	0	2
Course Objectives:					
Enable the students to					
1. Develop expertise in using economic concepts to analyse current issues pertaining to natural resource uses and policies.					
2. Design the best resource exploring policies over time, using dynamic programming and optimum control techniques.					
3. Gain insight into problems related to the connection that exists between poverty, economic development, and the depletion of natural resources.					
Course Outcomes:					
The students will be able to					
1. Exposed to a broad spectrum of topics associated with natural resource challenges, addressing optimal management, resource scarcity, and overexploitation.					

2. Manage natural resources efficiently using the application of optimum control techniques. 3. Familiar with a variety of laws and regulations that influence how natural resources are used and protected 4. Understand the impacts of land use and environmental management decisions on ecosystems and society 5. Acquire knowledge on Institutional arrangements for conservation and management of common 6. Capable of using EXCEL Solver for solving optimal control problems	
Theory	
Block 1: Concepts	
Unit: I: Concepts	
Natural resources - definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources. Fundamental equation of renewable resources.	
Block 2: Models and Management	
Unit: I: Models for Economic View of Natural Resources	
Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.	
Unit II: Management of Water Resources	
Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery.	
Block 3: Regulations and Planning	
Unit I: Property Rights	
Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources – Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.	
Unit II: Dynamics of Resource Economics	
Resource scarcity – Natural resource degradation – Poverty and resource degradation – Natural resource accounting - Pricing and valuation of natural resources – Natural resources policy. Practical Derivation of the fundamental equation of renewable resources-Estimation of growth curves and stock dynamics for fishery and forestry resources. Simple two period problem of optimal resource use – Numerical solution for simple two-period model of dynamic efficiency in natural resource extraction. Multi-period dynamic efficiency – Using Excel Solver in solving dynamic natural resource harvesting problems. Using analytical solution procedures for solving natural resource management problems – Optimal control.	
References	
1. Hackett SC. 2001. Environmental and Natural Resource Economics: Theory, Policy and the Sustainable Society. M.E. Sharpe, Armonk, NY. 2. Hartwick JM and Olewiler ND. 1998. The Economics of Natural Resource Use. 2nd Ed. Addison-Wesley Educational Publ. 3. Kerr JM, Marothia DK, Katar Singh, Ramasamy C and Bentley WR. 1997. Natural Resource Economics: Theory and Applications in India. Oxford & IBH. 4. Pearce DW and Turner K. 1990. Economics of Natural Resources and the Environment. John Hopkins Univ. Press. 5. Prato T. 1998. Natural Resource and Environmental Economics. Iowa State Univ. Press. 6. Sengupta R. 2000. Ecology and Economy, an Indian Perspective. Oxford Univ. Press. 7. Tietenberg T. 2003. Environment and Natural Resource Economics. 6th Ed. Addison Wesley.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Environmental Economics	L	T	P	C
24AG3177		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the some of the basic facts surrounding contemporary environmental pollution and natural resource issues					
2. Identify the causes of environmental degradation and the policy measures to deal with environmental problems.					
3. Develop students to make decisions on utilization of resources, environmental protection and conservation policies					
Course Outcomes:					
The students will be able to					
1. Understand the concept of pollution and externalities caused by economic activity.					
2. Work out the economics of productions activities in terms of losses to environment.					
3. Explain the economic principles that define and guide the efficient protection, restoration, development, and allocation of scarce environmental					
4. Understand basic economic concepts and tools used in the analysis of environmental problems					
5. Examine accounting regulations and policies for the sustainable development					
6. Enumerate the policy options to prevent environmental damage and prevent misuse of natural resources.					
Theory					
Block 1: Overview					
Unit: I: Overview of Environmental Economics					
Environmental pollution as a consequence of market failure - Causes and consequences of market failure - Externalities - Public goods and externalities-Economics of pollution – Private vs. Social cost of environmental pollution – Property rights, environment and development – Theory of environmental policy.					
Block 2: Assessment and Development Dynamics					
Unit: I: Economic Assessment					
Environmental cost benefit analysis - Environmental impact assessment techniques Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.					
Unit II: Developmental Aspects					
Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts - Population and environmental quality - poverty and environmental degradation – Sustainable development – Indicators of sustainable development – Issues in sustainable development.					
Block 3: Regulations and Issues					
Unit I: Accounting, Policies and Regulation					
Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution - Coastal externalities - Urbanization and environment - Basic approaches to environmental policy (Tax, subsidy, pollution permits, etc.) Green taxes – Political economy of environmental regulation and management.					
Unit II: Environmental Issues					
Transboundary environmental problems - Economics of global warming, climate change and emission trading - Environment, international trade and development					
Practical					
Contemporary global environmental global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms Criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques, Recreation demand models of environmental valuation, Contingent valuation techniques, Environmental Resource Accounting Techniques, Discussion on the techniques dealing with air pollution and review of case studies, on					

air pollution and its impacts – forest, environment and wild life conservation, Green GDP and Green house insurance, Practical considerations and comparison of instruments of environmental policy, Non-point source pollution control methodologies, Environment in macroeconomic modelling, Meta-analysis, economic valuation and environmental economics, Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems, related to environment, Input output analysis, technology and the environment, Computable general equilibrium models for environmental economics and policy analysis

References

1. Hackett SC. 2001. Environmental and Natural Resource Economics: Theory, Policy and the Sustainable Society. ME. Sharpe, Armonk, NY.
2. Hartwick JM and Olewiler ND. 1998. The Economics of Natural Resource Use. 2nd Ed. Addison-Wesley Educational Publ.
3. Kerr JM, Marothia DK, Katar Singh, Ramasamy C and Bentley WR. 1997. Natural Resource Economics: Theory and Applications in India. Oxford & IBH.
4. Pearce DW and Turner K. 1990. Economics of Natural Resources and the Environment. John Hopkins Univ. Press.
5. Prato T. 1998. Natural Resource and Environmental Economics. Iowa State University Press.
6. Sengupta R. 2000. Ecology and Economy, an Indian Perspective. Oxford University Press.
7. Tietenberg T. 2003. Environment and Natural Resource Economics. 6th Ed. Addison Wesley

Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Operations Research	L	T	P	C
24AG3178		2	0	1	3

Course Objectives:

Enable the students to

1. Analyse different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.
2. Learn using various software package for solving linear programming and integer programming models.
3. Acquire knowledge on advanced methods for large-scale transportation and assignment problems

Course Outcomes:

The students will be able to

1. Gain expertise in formulating problems of management into mathematical form and work out the optimum solutions.
2. Solve deterministic and Probabilistic inventory control models for known and unknown demand of the items.
3. Obtain knowledge in linear and non-linear programming problems and they can solve the problems using software
4. Acquire in depth knowledge in constrained and unconstrained optimization techniques
5. Apply the knowledge of different models in better decision making and controlling of the firm
6. Apply the dynamic programming to solve problems of discrete and continuous variables.

Theory

Block 1: Concepts

Unit: I: Concepts

Elementary concepts and objectives of Operations Research, Review of Linear programming - Assumptions & Methods, Non-linear programming problem - Quadratic programming, Multi Objective Programming (MOP)

Block 2: Inventory and Models

Unit: I: Inventory- A Review

Inventory control models, costs involved in Inventory management, types of inventory, Economic order quantity model, Waiting line models: Waiting line problem, Characteristics of a waiting line system, Single channel model	
Unit II: Models	
Markov Chains, Sequencing, Replacement models, Transportation and Assignment problems.	
Block 3: Decision Making	
Unit I: Decision Making	
Decision making under risk and uncertainties, decision problem, maximax criterion, maximin criterion, minimax regret criterion, Laplace criterion, Pay off tables, Decision trees, Expected value of perfect information	
Unit II: Game Theory	
Game Theory – Two-person Zero sum game, Simulation, Network Analysis- PERT & CPM	
Practical	
Linear and Non-linear programming problem, Quadratic programming, Multi-Objective Programming- Goal Programming, Lexicographic, Weighted Sum, Determining economic order quantity, reorder levels of EOQ model. Waiting line problem, Problems on Markov Chains, Sequencing and Replacement models. Formulating and solving transportation type problems, Assignment problems as a special type of transportation problem. Solving deterministic and probabilistic queuing models Structuring and solving decision trees for optimal decisions Game theory, Simulation, Developing network (PERT/CPM) diagrams and determining the critical path.	
References	
1. Taha HA. Operations Research: An Introduction. 2. Veerabhadrappe H. An Introduction to Operations Research. 3. Gupta PK and Hira DS. Operations Research. 4. Sharma R. Operations Research. 5. Sharma JK. Operation Research. 6. Greene WH. 2002. Econometric Analysis. Pearson Education. 7. Johnston J and Dinardo J. 2000. Econometric Methods. Mc Graw-Hill. 8. Koutseyianis A. 1997. Theory of Econometrics. Barner & Noble.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Econometrics For Agri-Business	L	T	P	C
24AG3181		2	0	1	3
Course Objectives:					
Enable the students to 1. Learn database analysis of market and policy variables to back up their business strategies. 2. The emphasis will be given on application rather than theoretical details. 3. Apply statistical methods to conduct empirical research					
Course Outcomes:					
The students will be able to 1. Acquire the basic knowledge of econometrics 2. Develop econometric models and test its application in the agribusiness environment 3. Ability to perform analyses of economic data based on a broad knowledge of the linear regression model 4. Engage in quantitative analysis of economic phenomenon 5. Develop competencies in understanding economic policies through a project-based approach 6. Comprehend the causality concept in an empirical context					
Theory					

Introduction: Correlation theory, Basic concept of regression analysis, assumptions of regression model, theory of OLS, properties of least square estimates, maximum likelihood, hypothesis testing, interval estimation, prediction in linear regression model. Heteroskedasticity and autocorrelation, multicollinearity, specification errors, selection of regressors, dummy variables, autoregressive and distributed models. Set of regression equations, causality and simultaneity: application. Time series econometrics- stationarity, unit roots, and co-integration, error- correction model, AR, MA, ARMA, ARIMA processes. Qualitative dependent variables – LPM, Logit, and probit models.

References

1. Gujarati, Damodar, Basic Econometrics, McGraw-Hill Company
2. James H. Stock and Mark W. Watson: Introduction to Econometrics, Pearson Education

Recommended by the Board of Studies 02.02.2024

Approved by the Academic Council 11.05.2024

Course Code	Research Methods-I		L	T	P	C
24AG3182			2	0	1	3
Course Objectives:						
Enable the students to						
1. Develop the knowledge and skills required to specify, evaluate, and utilize different types of unstructured and semi-unstructured information. 2. Develop competence in problem formulation, hypothesis generation, and methods of carrying scientific research in situations where research work plays a critical role. 3. Learn by doing live projects and study the latest researches in different fields related to agri business.						
Course Outcomes:						
The students will be able to						
1. Learn about the basics of research methodology 2. Understand the application of research for problem-solving related to agribusiness environment 3. Comprehend the basics of research methodology and apply them in research/ project work 4. Demonstrate the ability to choose methods appropriate to research objectives. 5. Develop skills in qualitative and quantitative data analysis and presentation 6. Develop advanced critical thinking skills						
Theory						
Block 1: Overview of Research Methodology						
Unit I						
Translating problems to research issues: Selection of qualitative vs quantitative research definitions, objectives, research methodologies rationale, sample/sources of data, data collection techniques, Questionnaire designing: use of measurement and scaling techniques, reliability testing.						
Unit II						
Fieldwork: Data collection, gaining access and entry, ethical considerations, identifying key informants, validation and evaluation of fieldwork, data preparation, field notes and recording						
Unit III						
Hypothesis Development and Theoretical Modelling. Business Analytics, Business Intelligence						
Block 2: Introduction To Business Analytics						
Unit I						
Types of Business Analytics, Introduction to predictive modeling/analytics. Linear programming, Contemporary applications of marketing research						
References						
1. Black TR. 1993. Evaluating Social Science Resea7rch - An Introduction. SAGE Publ. 2. Creswell JW. 1999. Research Design - Qualitative and Quantitative Approaches. SAGE Publ. 3. Dhondyal SP. 1997. Research Methodology in Social Sciences and Essentials of Thesis						

Writing. Amman Publ. House, New Delhi.	
4. Kothari C.R. Gaurav Garg. 2019. Research Methodology Methods and Techniques. NEW AGE International Publishers	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Agri Input and Output Marketing	L	T	P	C
24AG3183		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand the dynamic and competitive field where a lot is to be done looking to the gap in technology existing and possible.					
2. Comprehend the manifolds ranging from farming practices to trading in domestic and international markets.					
3. Understand the research and articles to understand interesting changes going on in this field					
Course Outcomes:					
The students will be able to					
1. Develop an understanding of the existing practices of agri-input and output marketing in India					
2. Acquire deep learning about assessing the marketing cost and related efficiencies to make agricultural marketing profitable					
3. Analyze the presence of private players, infrastructure development, impact on prices, concept of e- mandi, are becoming more important to understand in the current scenario.					
4. Identify the role of different organizations in international trade and the share of agriculture in total exports.					
5. Increase their analytical capabilities with respect to products, market environment, and operational issues in the marketing of agricultural inputs.					
6. Develop an appropriate marketing strategy depending on the field conditions.					
Theory					
Block 1: Introduction to Agri Input and Out Marketing Environment					
Unit I					
Agriculture input and output marketing environment status, trends, market structure, infrastructure, competition, Government intervention in agricultural inputs and outputs marketing					
Unit II					
Buyers/users behavior, Market Segmentation, Product and Pricing, Promotion and advancement in promotional strategies, Marketing Channels for different agri inputs and outputs					
Block 2: Evaluation of Marketing Costs and Efficiencies					
Unit I					
Evaluation of marketing costs and efficiencies, WTO and Indian Agriculture, Case Studies- Competitive marketing strategies and advancements in agricultural marketing, International agri marketing practices					
References					
1. Agricultural Marketing in India by S.S. Acharya and N.L. Agarwal, CBS Publishers and Distributors, New Delhi 2021					
2. Marketing of Agricultural Products by Richard L. Kohls and Joseph, Prentice Hall of India, New Delhi, 2018					
3. Agriculture and Food Marketing in Developing Countries by Abbott, John Cave, Oxford, London, 2007					
4. State of Indian Farmer: Agriculture Marketing by S.S. Acharya, Academic Foundation, New Delhi 2004					
Recommended by the Board of Studies		02.02.2024			
Approved by the Academic Council		11.05.2024			

Course Code	Research Method-II	L	T	P	C
24AG3184		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand advanced analytical tools and their uses.					
2. Explore the computationally innovative methods and technologies for improving the qualitative skills of researchers					
3. Learn various quantitative analytical tools and advanced softwares to analyze the big data and interpret					
Course Outcomes:					
The students will be able to					
1. Apply the concepts of hypothesis testing in independent research					
2. Demonstrate the application of statistical analysis softwares through hands-on experience in agribusiness problem-solving methods					
3. Apply data mining techniques to business for performance improvement and decision-making					
4. Use advanced modeling software like SAS in market research					
5. Elucidate the significance of the software for handling large and complex pieces of data/information and manage and organize through simplified coding techniques					
Able to formulate new research hypotheses, develop models, and test their fit					
Theory					
Block 1: Hypothesis Testing					
Unit I					
Hypothesis testing, Analysis of variance and covariance, Correlation and regression, Discriminant and Logit analysis, Factor analysis, Cluster analysis, Multidimensional scaling and conjoint analysis.					
Block 2: Data Mining					
Unit I					
Data Mining, Data Mining Methods—Data Dredging, Data Fishing, Data Snooping and Process Mining—Business Process Discovery, Conformance Checking and Model Enhancement. Arena Modelling.					
Block 3: Applications of Statistical Software					
Unit I					
Applications of Statistical Softwares like SAS, Modelling with statistical softwares. Report preparation and presentation, International Marketing Research.					
References					
1. Cohen L, Lawrence M and Morrison K. 2005. Research Methods in Education (5th edition). OXford: OXford University Press.					
2. Denscombes M. 2010. The Good Research Guide: For small-scale social research projects. Maiden-Read: Open University Press.					
3. Dornyei Z. 2007. Research Methods in Applied Linguistics. Oxford: Oxford University Press.					
4. Kothari CR. 1980. Research Methodology: Research and Techniques, New Delhi: New Age International Publishers.					
5. Kumar R. 2011. Research Methodology: a step-by-step guide for beginners (3rd edition).					
6. Singh YK. 2006. Fundamental of Research Methodology and Statistics. New International (P)Limited, Publishers, New Delhi.					
Recommended by the Board of Studies		02.02.2024			
Approved by the Academic Council		11.05.2024			

Course Code	Natural Resource Management	L	T	P	C
24AG3185		2	0	0	2
Course Objectives:					
Enable the students to					

1. Able to obtain in-depth knowledge from the participants to look for ways to make responsible natural resource management decisions that will have an impact on all stakeholders. 2. Familiarize the students with the complexities of natural resource management from the perspective of development and environmental protection 3. To understand the role and contribution of NRM in economic development and people's livelihoods and life support systems especially, in the context of increasing depletion of resources and currently with liberalization, privatization, and globalization.
Course Outcomes:
The students will be able to 1. Demonstrate creativity and innovation in identifying and pursuing opportunities that produce environmental, social, or economic value. 2. Evaluate the feasible alternatives in terms of biological possibility, economic feasibility, and social acceptability. 3. Recognize and interpret resource problems and opportunities across spatial scales from local to global. 4. The ability to contextualize the changes taking place in the natural resource base and suggest strategies/plans in managing the resources. 5. Analyse the natural environment and appreciate the place of natural resources to living beings and the universe in general. 6. Link the promotion of sustainability and community resilience to agricultural, and other modes of tourism
Theory
Block 1: Introduction to Natural Resources
Unit I
Natural resources: Types and classification of natural resources, the concept of Economic value, relevance of environmental economics, ecosystem services, the direct and indirect economic benefit from – forest ecosystems, mountain ecosystems, mineral and water resources, ecotourism. Valuation and accounting: Supply and demand, conservation and management, cost/ benefit analysis, methods of costing, cost criteria, evaluating alternative projects, operational vs. total costs, determining benefiting vs. comprehensive stakeholders Application of resource accounting Methods of pricing resources- example forest and mineral resources.
Unit II
Economic resource theory and applications: Concept of CPR, open access, Ecological economics- methodology, economic valuation of non-market benefits, environmental accounting, population resources, and the environment, command and control vs. emission trading, emission trading vs. exposure trading, hotelling principle, future strategies for mineral resources.
Block 2: Overview of Natural Resource Management
Unit I
Natural Resource Management: Initial concept of market and marketing, NRM sectors product marketing and their roles, promoting NRM products- NTFPs, livestock, watershed, fisheries, agriculture and medicinal plants and ecotourism, Role of national and international organizations in the promotion of sustainable natural resource use and management.
Unit II
Concept of environmental services: Definitions, ecotourism, alternative examples, development of ecotourism in India and outside. Threats due to large scale ecotourism. Payment for Ecosystem Services, the ecotourism dilemmas: High value may also be high impact, bulk ecotourism and problems, stakeholder challenges, tourist carrying capacity. Ecotourism Policy and practices, national policy frame work, example – Madhya Pradesh & Uttarakhand State case. Successful ecotourism initiative, Criteria and Indicators for sustainable Ecotourism.
References
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Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Knowledge Management	L	T	P	C
24AG3186		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand the basics of the emerging area of Knowledge Management to students.					
2. Comprehend important concepts such as Knowledge management and Information Technology, Knowledge process, etc.					
3. Apply the knowledge-based theory of the firm to explain their existence, as well as other factors determining scale and scope					
Course Outcomes:					
The students will be able to					
1. Improve the quality of management decision-making by ensuring that reliable and secure knowledge, information, and data are available through the service lifecycle					
2. Explore the service provider to be more efficient and improve the quality of service, increase satisfaction, and reduce the cost of service by reducing the need to rediscover knowledge					
3. Understanding of the value that their services provide to customers and how benefits are realized from the use of those services					
4. Understand the need for business systems and processes through strategic analysis of ERP systems					
5. Recognize the organizational intellectual capital and its value in organizations					
6. Apply the knowledge-based theory of the firm to explain its existence, as well as other factors determining scale and scope					
Theory					
Block 1: Introduction to Knowledge Management					
Unit I					
The Knowledge Economy: Leveraging Knowledge, Data-Information- knowledge-Wisdom relationship, organizational knowledge, characteristics and Components of organizational knowledge –Building knowledge societies- Measures for meeting the challenges of implementing, KM programmes.					
Unit II					
Knowledge Management and Information Technology: Role Information Technology in Knowledge Management Systems, Knowledge Management tools, Creative effective Knowledge Management Systems through Information Technology, ERP and BPR, Data Warehousing and Data Mining.					
Block 2: Future of Knowledge Management and Industry Perspective					
Unit I					
Future of Knowledge Management and Industry perspective: Companies on the road to knowledge management, Knowledge Management in Manufacturing and service industry, challenges and future of Knowledge Management.					
Unit II					
The Knowledge Process: Universal appeal, Stages of KM Process, Knowledge Capital vs physical capital, Customer Relationship Management, Business Ethics And KM, The Promise of Internet and the Imperatives of the new age.					
Unit III					

Implementation of Knowledge Management: Discussion on Roadblocks to success, Business Intelligence and Internet platforms, web Portals, Information Architecture: A three-way Balancing Act, KM, the Indian eXperience, Net Banking in India. –Role of knowledge Management in Organisational Restructuring. -The Mystique of a Learning Organisation.

References

1. Mattison: Web Warehousing and Knowledge Management, Tata McGraw-Hill, 2009
2. Becerra Fernandez: Knowledge management: An Evolutionary view, PHI, 2009
3. Fernando: Knowledge Management, Pearson, 2009
4. B. Rathan Reddy: Knowledge management, Himalaya, 2009
5. Tapan K Panda: Knowledge Management, EXcel, 2009.
6. Barnes: Knowledge Management systems, Cengage, 2009.
7. Tiwana: *The Knowledge Management tool kit*, 2/e, Pearson Education, 2009.
8. Warier: *Knowledge Management*, Vikas Publishing House, 2009
9. Sislop: *Knowledge Management*, Oxford University Press, New Delhi, 2009
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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	Value-Chain Management in Agribusiness	L	T	P	C
24AG3187		2	0	0	2
Course Objectives:					
Enable the students to					
1. Understand the characteristics of Global Food Systems, the multiple variables impacting Global Food Systems					
2. Identify value chain thinking and how it differs from supply chain thinking,					
3. Acquire the knowledge of agri-food markets, what influences their supply and demand, and what sets them apart from other markets.					
Course Outcomes:					
The students will be able to					
1. Evaluate external factors such as population and income growth, globalization, climate change, technology, international trade in global food systems, agribusiness, and value chains,					
2. Recognize the role the consumer plays in the food system, markets, and value chains					
3. Identify and describe the components, processes and functions of value chains					
4. Reflect on and communicate the concept of value in any exchange of goods and services					
5. Describe and interpret factors that can affect value chain efficiency and effectiveness					
6. Apply value chain management concepts and skills to communicate improvements for business performance					
Theory					
Unit I: Global Food Systems and Value-Chains					
Characteristics of global food systems; identify the variables impacting global food systems; identify value chain thinking and how it differs from supply chain thinking; identify the role that external factors (for example, population and income growth, globalization, climate change, technology and international trade) play on global food systems, agribusiness and value chains; and identify the actors in, and characteristics of, value chains, demonstrated with the building of a value chain model.					
Unit II : Agribusiness Market Dynamics					
Characteristics of agri-food markets, what influences their supply and demand, and what sets them apart from other markets; identify the role that external factors, such as population and income growth, globalisation, climate change, technology and international trade, play on agri-food markets; interpret the key elements of supply and demand; and recognise the basic characteristics of supply and demand curves.					
Unit III: The Role of the Consumer					

Role the consumer plays in the food system, markets and value chains; recognise the consumer characteristics, trends and behaviours that influence value chains; and recognise some of the techniques used in market and consumer research to better understand consumer behaviour.

References

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2. Altekar RV. 2006. Supply Chain Management: Concepts and Cases. PHI
3. Chopra S, Meindl P and Kalra DV. 2016. Supply chain management: Strategy, Planning, and Operation, Pearson Education India
4. Mohanty RP. 2010. Indian Case studies in Supply Chain Management and other Learning Resources. OXford.
5. Chandrasekaran N. 2010. Supply Chain Management: Process, system and Practice. Oxford.

Recommended by the Board of Studies 02.02.2024

Approved by the Academic Council 11.05.2024

Course Code	Agri Entrepreneurship and Corporate Governance	L	T	P	C
24AG3188		1	0	0	1

Course Objectives:

Enable the students to

1. Understand the nature of entrepreneurship
2. Learn the challenges of starting new ventures and enable them to investigate, understand, and internalize the process of setting up a business.
3. Comprehend the importance of Corporate Good Governance and Business Ethics.

Course Outcomes:

The students will be able to

1. Understand the concept of agripreneurs and its application for starting a new venture
2. Develop functional plans like marketing, production, and financials for any business
3. Acquire the knowledge about business ethics and corporate governance
4. To provide students with advanced business knowledge and skills necessary to function as an effective leader, manager, or team member.
5. To provide opportunities for students to engage in the discovery and understanding of agriculture business & entrepreneurship knowledge that are both thought-provoking and relevant.
6. To engage students in project-based learning relevant to the study and understanding of agribusiness.

Theory

Block 1: Agri Entrepreneurship and Feasibility Studies

Unit I

Nature of Entrepreneurship: Concept, knowledge, skills requirement and functions; characteristic of successful entrepreneurs; a scenario in India and Abroad, entrepreneurship process; factors impacting emergence of entrepreneurship; managerial vs. entrepreneurial approach and the emergence of entrepreneurship, Risk Reduction strategies

Unit II

Starting the venture: generating business idea – sources of new ideas, methods of generating ideas, SWOT Analysis, environmental scanning, competitor and industry analysis; feasibility study – market feasibility, technical/operational feasibility, financial feasibility; drawing business plan; preparing project report; presenting business plan to investors.

Unit III

Functional plans: marketing plan – marketing research for the new venture, steps in preparing a marketing plan, contingency planning; organizational plan – a form of ownership, designing organization structure, job design, manpower planning; Financial plan – cash budget, working capital, proforma income statement, proforma cash flow, proforma balance sheet, break-even analysis.

Unit IV

Sources of finance: debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs, Government Grants and Subsidies, Entrepreneurship Promotion Schemes of Department of Industries (DIC), KVIC, SIDBI, NABARD, NSIC, APSFC, IFCI and IDBI etc.; legal issues – intellectual property rights patents, trademarks, copy rights, trade secrets, licensing; franchising.

Block 2: Introduction To Business Ethics and Corporate Governance

Unit I

Introduction To Business Ethics And Corporate Governance Unit 5: Necessity for Business Ethics- Salient Issues in Ethics and Commerce- Shadow Economy – Basic Principles in Ethics –Corporate Climate and corporate climate audits – Political Issues – Nature and theory of Ethics, Corporate Governance- Historical perspective and issues of Corporate Governance –Corporate Governance mechanisms – Corporate Governance Models, – The confederation of Indian Industry's initiative.; Corporate Social Responsibility

References

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3. David Martin: *Corporate Governance*, Viva, 2010.
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5. Barringer: *Entrepreneurship*, Pearson, 2015.
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7. V. Balachandran and V. Chandrasekaran: *Corporate Governance & Social Responsibility*, PHI, 2009.
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Recommended by the Board of Studies	02.02.2024

Approved by the Academic Council	11.05.2024

Course Code	International Food and Agri-Business	L	T	P	C
24AG3189		2	0	0	2

Course Objectives:

Enable the students to

1. Acquaint the students with the fundamentals of international business, its environment, and its complexities.
2. Learn the application of a broad range of business concepts - economic, financial, and marketing - to international agri-food business and marketing
3. Expose to multiple dimensions of the field and impart international perspective to business decisions.

Course Outcomes:

The students will be able to

1. Critically examine the application of international business and marketing theory in food and agribusiness
 2. Analyse the changing international environment, customers, and agri-food market
 3. Critically examine steps required to export agri-food products
 4. Evaluate price and exchange rate risk applied to agri-food exports
 5. Examine the global investment strategies and collaborations to manage the supply chain
- Evaluate the complexities of international negotiations

Theory

Block 1: Global Trends In International Trade

Unit I

Global trends in international trade and finance; dimensions and modes of IB; structure of IB environment; risk in IB; organizational structure for IB; world trading system and impact of WTO;

exchange rate systems; global financial system; barriers to IB; international business information and communication.	
Unit II	
Foreign market entry strategies; country evaluation and selection; factors affecting foreign investment decisions; impact of FDI on home and host countries; types and motives for foreign collaboration; control mechanisms in IB.	
Block 2: Global Manufacturing and Material Management	
Unit I	
Decisions concerning global manufacturing and material management; outsourcing factors; managing global supply chain; International product life cycle, product and branding decisions; managing distribution channels; international promotion mix and pricing decisions; counter trade practices; mechanism of international trade transactions. EXIM policy of India. Export costing and pricing, Export procedures and export documentation. Export assistance and incentives in India.	
Unit II	
Harmonizing accounting difference across countries; currency translation methods for consolidating financial statements; the LESSARD-LORANGE Model; cross cultural challenges in IB; international staffing decisions; compensation and performance appraisal of expatriate staff; ethical dilemmas and social responsibility issues.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Communication for Management Teachers	L	T	P	C
24AG3190		2	0	0	2
Course Objectives:					
Enable the students to					
1. Learn innovative techniques to make teaching and learning interesting, practical, and effective.					
2. Understand the various types of researches done for methodological and effectiveness aspects.					
3. Relate all the methods of communication for management teaching in learning by doing methods and present the various researches done in this field.					
Course Outcomes:					
The students will be able to					
1. Understand the scope of communication and learn its importance and implication strategies.					
2. Recognize and learn the sub-skills of listening and speaking and be able to deliver effectively in real-time contexts.					
3. Imbibe the mechanics of writing and construct effective paragraphs that befit in a longer composition.					
4. Demonstrate the ability to accomplish communicative goals					
5. Use different forms of written communication techniques to make effective internal and external business correspondence.					
6. Apply the case-based learning to improve the logical thinking					
Theory					
Block 1: Management Education					
Unit I					
Management education: Action gaps in education and latest developments and required skills					
Unit II					
Communication: Active listening, group communication, Language process Presentation on readings- recorded and graded: Oral presentation & computer-assisted presentations					
Block 2: Theory and Techniques of Communication in Management					
Unit I					

Communication: Active listening, group communication, Language process Presentation on readings- recorded and graded: Oral presentation & computer-assisted presentations	
Unit II	
Theory and techniques: Didacticism, Group work & discussion method, Simulation, facilitation skills and styles for experiential learning, Emotional perspective in teaching	
Unit III	
Learning in management education: Experiential learning, Action Learning, Group learning, Simulation and games, Role Play, Teaching and learning through Electronic Media	
Block 3: Case Teaching and Writing	
Unit I	
Case method of teaching: Writing a case and teaching note, Critiquing a research article	
References 1. Campoy, Renee. Case Study Analysis in the Classroom: Becoming a Reflective Teacher. Sage Publications, 2005. 2. Ajmani, J. C. Good English: Getting it Right. New Delhi: Rupa Publications, 2012. 3. Thill, John V. & Courtland L. Bovée, Excellence in Business Communication, 10th edition. Boston: Pearson, 2013.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Innovative Approaches in Fruit Breeding	L	T	P	C
24HO4146		3	0	0	3
Course Objectives:					
Enable the students to					
1. Acquire knowledge on modern trends in fruit breeding					
2. Understand genetics of important traits and inheritance patterns					
3. Gain expertise on breeding strategies for specific traits in fruit crops					
Course Outcomes:					
The students will be able to					
1. Comprehend and analyze the current trends in fruit breeding					
2. Evolve breeding strategies for fruit trees with low canopy volume to build HDP & UHDP					
3. Understand the incompatibility systems in fruit crops and evolve suitable strategies.					
4. Analyze the inheritance pattern and genetics of important traits to undertake trait specific breeding.					
5. Analyze plant architecture and stress tolerance for wider adaptability and amenability to mechanization					
6. Apply molecular techniques for improvement of fruit crops.					
Theory					
Block 1: Introduction					
Unit I					
Current Trends and Status: Modern trends in fruit breeding –with major emphasis on precocity, low tree volume, suitability for mechanization, health benefits, etc.					
Block 2: Genetic Mechanisms					
Unit I					
Inheritance Patterns and Breeding Systems: Genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits.					
Block 3: Breeding for Specific Traits					
Unit I					
Plant Architecture, Stress Tolerance and Fruit Quality: Recent advances in crop improvement efforts-wider adaptation, plant architecture, amenability to mechanization, fruit quality attributes, stress tolerance, crop specific traits; use of apomixis, gene introgression and wide hybridization (alien genes).					

Block 4: Fast-Track Breeding	
Unit I	
Transgenics, Markers and Genomics: Molecular and transgenic approaches in improvement of selected fruit crops; fast track breeding – marker assisted selection and breeding (MAS and MAB), use of genomics and gene editing technologies.	
Crops	
Mango, banana, guava, papaya, Citrus, grapes, pomegranate, litchi, apple, pear, strawberry, kiwifruit, plums, peaches, apricot, cherries, nectarines, nut crops.	
References	
1. Al-Khayari J, Jain SN and Johnson DV. 2018. <i>Advances in Plant Breeding Strategies</i>. Vol. 3: <i>Fruits</i>. Springer. 2. Badenes S and Byrne DH. 2012. <i>Fruit Breeding</i>. Springer. 3. Hancock JF. 2008. <i>Temperate Fruit Crop Breeding: Germplasm to Genomics</i>. Springer. 4. Kole C and Abbott AG. 2012. <i>Genetics, Genomics and Breeding of Stone fruits</i>. CRC. 5. Kole, C. 2011. <i>Wild Crops Relatives: Genomics and Breeding Resources: Tropical and Subtropical Fruits</i>. Springer-Verlag. 6. Kole C. 2011. <i>Wild Crops Relatives: Genomics and Breeding Resource: Temperate Fruits</i>. Springer-Verlag. 7. Jain SN and Priyadarshan PM. 2009. <i>Breeding Plantation and Tree Crops: Tropical Species, Temperate Species</i>. Springer -Verlag. 8. Janick J and Moore JN, 1996. <i>Fruit Breeding</i>. Vols. I-III. John Wiley & Sons, USA. 9. Orton T. 2019. <i>Methods in Fruit Breeding</i>. Elsevier. 10. Singh SK, Patel VB, Goswami AK, Prakash J and Kumar C. 2019. <i>Breeding of Perennial Horticultural Crops</i>. Biotech Books. Delhi.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Modern Trends in Fruit Production	L	T	P	C
24HO4147		3	0	0	3
Course Objectives:					
Enable the students to					
1. Gain knowledge on recent advances in propagation, rootstock, planting systems using HDP and UHDP					
2. Apply crop modeling, precision farming and decision support systems in fruit crop production.					
3. Evaluate the physical and chemical regulation and integrate modern approaches in water and nutrient management.					
Course Outcomes:					
The students will be able to					
1. Understand the current scenario and challenges in fruit production					
2. Exploit recent methods of plant propagation with improved rootstocks					
3. Enhance productivity of fruit crops through precision farming techniques					
4. Apply integrated approaches to regulate physiology and developmental of fruit crops					
5. Design efficient water and nutrient application methods to overcome stress effects					
6. Plan and propose strategies for total quality management of fruit crops					
Theory					
Block 1: Introduction					
Unit I					
General Concepts and Current Scenario: National and International scenario, national problems.					
Block 2: Advanced Technologies					
Unit I					

Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – root stocks, planting systems, High density planting, crop modeling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation.	
Block 3: Management Practices	
Unit I	
Overcoming Stress and Integrated Approaches: Effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Physiological disorders, Total quality management (TQM) – Current topics.	
Crops	
Mango, Banana, Grapes, Citrus, Papaya, Litchi, Guava, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherry, Almond, Walnut, Pecan, Strawberry, Kiwifruit.	
References	
1. Bartholomew DP, Paull RE and Rohrbach KG. eds. 2002. The Pineapple: Botany, Production, and Uses. CAB International. 2. Bose TK, Mitra SK and Sanyal D. Eds. 2002. <i>Fruits of India – Tropical and Sub- Tropical</i>. 3rd Ed. Vols. I, II. Naya Udyog, Kolkata, India. 3. Dhillon WS and Bhatt ZA. 2011. <i>Fruit Tree Physiology</i>. Narendra Publishing House, New Delhi. 4. Dhillon WS. 2013. <i>Fruit Production in India</i>. Narendra Publishing House, New Delhi. 5. Gowen S. 1995. <i>Bananas and Plantains</i>. Chapman & Hall Publication, US. Litz RE. ed. 2009. <i>The Mango: Botany, Production and Uses</i>. CAB International. 6. Peter KV. 2016. <i>Innovations in Horticulture</i>. NIPA, New Delhi. 7. Robinson JC and Saúco VG. 2010. <i>Bananas and Plantains</i> (Vol. 19). CAB International. 8. Samson JA. 1980. <i>Tropical Fruits</i>. Longman, USA.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Recent Developments in Growth Regulation	L	T	P	C
24HO4138		3	0	0	3
Course Objectives:					
Enable the students to					
1. Realize the impact of climate change on the physiological processes in fruit crops					
2. Evaluate the influences of plant growth regulators in fruit crop production					
3. Understand the regulatory mechanisms of the developmental processes associated with fruit production					
Course Outcomes:					
The students will be able to					
1. Analyse the eco-physiological influences on growth and development of fruit crops					
2. Relate the knowledge gained on the biosynthesis of growth regulators on the molecular and genetic approaches in crop growth regulation					
3. Manipulate various developmental processes in fruit production through the use of growth regulators					
4. Practice chemical regulation of flowering, fruit set and fruit production					
5. Apply skills acquired on canopy management of orchards					
6. Gain expertise in regulation of propagation, fruit maturity and ripening of fruits.					
Theory					
Block 1: Introduction					
Unit I					
Current Concepts and Principles: Eco-physiological influences on growth and development of fruit crops-flowering, fruit set- Crop load and assimilate partitioning and distribution.					
Block 2: Growth Substances					
Unit I					

Phytohormones and Growth Regulators: Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

Block 3: Growth and Development

Unit I

Regulation of Developmental Processes: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruit-set and development, fruit drop, parthenocarp, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.

References

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2. Buchanan B, Gruissem W and Jones R. 2002. *Biochemistry and Molecular Biology of Plants*. John Wiley & Sons, US.
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5. Richard N. Artica. 1995. *Plant Growth Substances – Principles and Applications*. Chapman & Hall, USA.
6. Roberts J, Downs S and Parker P. 2002. *Plant Growth Development*. In: *Plants* (I. Ridge, Ed.), Oxford University Press.
7. Salisbury FB and Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publication.

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Course Code	Biodiversity and Conservation of Fruit Crops	L	T	P	C
24HO4139		2	0	1	3
Course Objectives:					
Enable the students to					
1. Understand principles of biodiversity and remember the centers of origin of fruit crops					
2. Gain knowledge on collection, maintenance, characterization and methods of germplasm conservation of fruit crops					
3. Gain knowledge on regulatory horticulture, germplasm exchange, quarantine and IPR					
Course Outcomes:					
The students will be able to					
1. Gain knowledge on centers of fruit crop domestication and germplasm availability of fruit crops.					
2. Evaluate the various conservation methods of genetic resources.					
3. Collect, maintain and characterize germplasms of fruit crops.					
4. Apply knowledge of regulatory horticulture, germplasm exchange and quarantine in germplasm conservation of fruit crops.					
5. Elaborate the requirements for phytosanitary certification, IPR, Breeder's rights and farmer's rights.					
6. Document local biodiversity and evaluate the benefits and procedures of GI protection and GI tagged fruit varieties in India.					
Theory					
Block 1: General Aspects					
Unit I					

Issues, Goals and Current Status: Biodiversity and conservation; issues and goals- needs and challenges; present status of gene centres; world's major centres of fruit crop domestication; current status of germplasm availability/ database of fruit crops in India.

Block 2: Germplasm Conservation

Unit I

Collection, Maintenance and Characterization: Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections. Germplasm conservation- *in situ* and *ex situ* strategies, on farm conservation; problem of recalcitrancy- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.

Block 3: Regulatory Horticulture

Unit I

Germplasm Exchange, Quarantine and Intellectual Property Rights: Regulatory horticulture, inventory and exchange of fruit and nut germplasm, plant quarantine, phyto-sanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV and FR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India.

Practical

Documentation of germplasm- maintenance of passport data and other records of accessions (2); Field exploration trips and sampling procedures (2); Exercise on *ex situ* conservation – cold storage, pollen/ seed storage (2); Cryopreservation (2); Visits to National Gene Bank and other centers of PGR activities (2); Detection of genetic constitution of germplasm (2), Germplasm characterization using a standardised DUS test protocol (2); Special tests with biochemical and molecular markers (2).

References

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Course Code	Arid and Dryland Fruit Production	L	T	P	C
24HO4140		2	0	0	2
Course Objectives:					
Enable the students to					

1. Understand the characteristics, problems and constraints in arid fruit production 2. Gain knowledge in aspects of dryland fruit production and crop regulation 3. Evolve strategies for management of abiotic stresses for arid region fruit production	
Course Outcomes:	
The students will be able to 1. Understand the characteristics and constraints in fruit production 2. Distinguish features of fruit species adaptable for arid zone cultivation 3. Apply advanced propagation techniques for root stocks and high-density planting system of fruit crops 4. Analyse the crop regulation methods and the effects of physiology and development of arid crops 5. Apply modern approaches of crop modeling to mitigate stress effects and total quality management of arid fruit crops 6. Adopt precision farming and decision support systems for water and nutrient management of dryland fruit crops	
Theory	
Block 1: Introduction	
Unit I	
General Concepts and Current Scenario: Characteristics features and major constraints of the arid and dryland region, distinguishing features of the fruit species trees for adaptation in adapting to the region, nutritional and pharmaceutical importance, national problems.	
Block 2: Advanced Technologies	
Unit I	
Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – root stocks, planting systems, High density planting, crop modelling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation, effects on physiology and development, influence of stress factors.	
Block 3: Management Practices	
Unit I	
Stress Mitigation and Integrated Approaches: Strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, total quality management (TQM) – Current topics.	
Crops	
Aonla, Annonas, ber, bael, jamun, date palm, cactus pear, khejri, kair, pilu, lasoda, manila, tamarind, monkey jack, mahua, khirni, amra, seabuckthorn, chilgoza, cafel, rhododendron, box myrtle, chironji, phalsa, karonda, woodapple, paniala and other minor fruits of regional importance	
References	
1. Hiwale S. 2015. <i>Sustainable Horticulture in Semiarid Drylands</i>. Springer. 2. Krishna H and Sharma RR. 2017. <i>Fruit Production – Minor Fruits</i>. Daya Publishing House, Delhi. 3. More T A, Singh RS, Bhargava R and Sharma BD. 2012. <i>Arid Horticulture for Nutrition and Livelihood</i>. Agrotech Publishing Academy, Udaipur (Rajasthan). 4. Pareek OP, Sharma S and Arora RK. 2007. <i>Underutilised Edible Fruits and Nuts</i>, IPGRI, Rome. 5. Peter K.V. 2010. <i>Underutilized and Underexploited Horticultural Crops</i>. NIPA, New Delhi. 6. Saroj PL, Dhandar DG and Vashishta BB. 2004. <i>Advances in Arid Horticulture</i>, Vol.-1 <i>Present Status</i>. IBDC, Lucknow. 7. Saroj P L and Awasthi OP. 2005. <i>Advances in Arid Horticulture</i>, Vol: II: <i>Production Technology of Arid and Semiarid Fruits</i>. IBDC, Lucknow. 8. Sontakke MB. 2014. <i>Production and Management</i>	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Advanced Laboratory Techniques	L	T	P	C
24HO3141		2	0	1	3
Course Objectives:					
Enable the students to					
1. Acquire knowledge on safety measures, laboratory maintenance and calibration of equipments 2. Gain expertise on sampling procedures, destructive and non-destructive analysis of fruits 3. Gain hands on experience in chromatographic and microscopic techniques and sensory analysis of fruits					
Course Outcomes:					
The students will be able to					
1. Calibrate and standardize laboratory instruments and determine proximate composition of horticulture produce 2. Apply safety measures in the laboratory and maintain the laboratory in working order 3. Prepare and analyze samples using destructive and non-destructive methods 4. Perform basic chromatographic and electrophoresis techniques on fruit samples 5. Apply nuclear and advanced microscopic techniques for biochemical analysis of horticulture produce 6. Perform sensory evaluation of horticultural produce					
Theory					
Block 1: General Aspects					
Unit I					
Safety Measures and Laboratory Maintenance: Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.					
Block 2: Qualitative and Quantitative Analysis					
Unit I					
Destructive and Non-destructive Analysis Methods: Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops.					
Unit II					
Chromatographic and Microscopic Analysis: Basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra filtration. Application of nuclear techniques in harvested produce. Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in horticultural produce.					
Unit III					
Sensory Analysis: Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.					
Practical					
Determination of moisture, relative water content and physiological loss in weight (2) Determination of biochemical components in horticultural produce (3); Calibration and standardization of instruments (1); Textural properties of harvested produce (1); Determination of starch index (SI) (1); Specific gravity for determination of maturity assessment, and pH of produce (1); Detection of adulterations in fresh as well as processed products (2); Non-destructive determination of colour, ascorbic acid, vitamins, carotenoids, sugars and starch (2); Estimation of rate of ethylene evolution using gas chromatograph (GC) (2); Use of advanced microscopes (fluorescent, scanning electron microscope, phase contrast, etc.) (2)					
References					
1. AOAC International. 2003. <i>Official Methods of Analysis of AOAC International</i>. 17th Ed. 2. Gaithersburg, MD, USA, Association of Analytical Communities, USA. 3. Clifton M and Pomeranz Y. 1988. <i>Food Analysis-Laboratory Experiments</i>. AVI Publication, USA.					

4. Leo ML. 2004. <i>Handbook of Food Analysis</i> . 2nd Ed. Vols. I-III, USA. 5. Linskens HF and Jackson JF. 1995. <i>Fruit Analysis</i> . Springer. 6. Pomrenz Y and Meloan CE. 1996. <i>Food Analysis – Theory and Practice</i> . CBS, USA. 7. Ranganna S. 2001. <i>Handbook of Analysis and Quality Control for Fruit and Vegetable Products</i> . 2nd Ed. Tata-McGraw-Hill, New Delhi. 8. Thompson AK. 1995. <i>Post Harvest Technology of Fruits and Vegetables</i> . Blackwell Sciences. USA.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

Course Code	Abiotic Stress Management in Fruit Crops	L	T	P	C
24HO3144		2	0	1	3

Course Objectives:
Enable the students to

1. Upgrade knowledge on basic aspects and principles of various abiotic stresses in fruit crops
2. Assess the impact of stress on physiology and performance through stress indices and remote sensing methods
3. Adopt stress mitigation measures and conservation practices under different abiotic stress situations

Course Outcomes:
The students will be able to

1. Acquire knowledge on various types of abiotic stresses and their effects
2. Analyze the physiological processes underlying abiotic stresses and biochemical factors associated with stress
3. Assess the impact of stress using stress indices and perform crop modelling for stress situations under different cropping systems
4. Analyze adaptive features of fruit crops for survival under stress and interaction among different stresses
5. Adopt mitigation measures and conservation practices and prepare contingency plans to mitigate different stress conditions
6. Recommend different fruit crops for different abiotic stress situations

Theory
Block 1: Introduction
Unit I

Basic Aspects and Principles: Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution – increased level of CO₂, industrial wastes, impact of stress in fruit crop production, stress indices, physiological and biochemical factors associated with stress, fruit crops suitable for different stress situations.

Block 2: Stress Impact
Unit I

Assessment, Physiology and Performance: Crop modeling for stress situations, cropping systems, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity.

Block 3: Stress Management
Unit I

Mitigation Measures and Conservation Practices: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, stability and sustainability indices.

Practical

Seed treatment/ hardening practices (2); Container seedling production (2); Analysis of soil moisture estimates (FC, ASM, PWP) (1); Analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate, etc. under varied stress situations (5); Biological efficiencies, WUE, solar energy conversion and efficiency (2); Crop growth sustainability indices and economics of stress management (2); Visit to orchards and watershed locations (2).

References

1. Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC Publication, USA.
2. Christiansen, MN and Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley International Science, USA.
3. Kanayama Y and Kochetor. 2015. *Abiotic Stress Biology in Horticultural Plants*. Springer.
4. Kramer PJ. 1980. *Drought Stress and the Origin of Adaptation*. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons, USA.
5. Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy, India.
6. Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC Publication, USA.
7. Rao NKS, Shivashankar KS and Laxman RH. 2016. *Abiotic Stress Physiology of Horticultural Crops*. Springer.
8. Turner NC and Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons, USA.

Recommended by the Board of Studies 02.02.2024

Approved by the Academic Council 11.05.2024

Course Code	Smart Fruit Production	L	T	P	C
24HO3145		2	0	0	2

Course Objectives:

Enable the students to

1. Gain knowledge on application of artificial intelligence systems in fruit production
2. Apply crop modelling, forecasting and nanotechnological approaches in fruit crop production
3. Utilize automated protected structures, drones and robots to enhance fruit production

Course Outcomes:

The students will be able to

1. Acquire knowledge on hi-tech innovations in fruit production by application of Artificial Intelligence
2. Perform crop modelling by use of GIS and remote sensing techniques
3. Utilize GIS and GPS systems in hi-tech nursery production under protected structures
4. Apply nanotechnological approaches for smart nutrient, herbicide and pesticide delivery in fruit farming
5. Mechanize and automatize fruit production systems by use of drones and robots for planting, weeding, harvesting and other operations
6. Analyze the use of hydroponics and aeroponics systems in crop production

Theory

Block 1: Introduction

Unit I

Importance and Overview: Introduction and importance; concepts and applications of artificial intelligence systems; case studies in horticulture

Block 2: Crop Modelling and Forecasting

Unit I

GIS, Sensors and Wireless Systems: Application of sensors in fruit production, crop monitoring – crop load and stress incidence forecast modules, remote sensing, Geographical Information System (GIS), Differential Geo-Positioning System (DGPS) hi-tech nursery production of fruit crops under protected conditions, ultra modern wireless based drip irrigation network.

Block 3: Nanotechnology	
Unit I	
Concepts and Methods: Nanotechnology for smart nutrient delivery in fruit farming, concepts and methods, practical utility, nano-fertilizers, nano-herbicides; nano-pesticides	
Block 4: Innovative Approaches	
Unit I	
Mechanization, Automation and Robotics: Production systems amenable to automation and mechanization; automated protected structures (turnkey systems); hydroponics, aeroponics, bioreactors for large scale plant multiplication; Use of drones and robotics in fruit growing – robotic planters, sprayers, shakers, harvesters, stackers, etc. Visit to Hi-tech facilities.	
References	
1. Chadha <i>et al.</i> 2017. <i>Doubling Farmers Incomes through Horticulture</i>. Daya Publishing House, New Delhi. 2. Chadha <i>et al.</i> 2019. <i>Shaping the Future of Horticulture</i>. Kruger Brentt Publishers, UK. 3. Hewett EW. 2013. <i>Automation, Mechanization and Robotics in Horticulture</i>. In: Workshop on Emerging Postharvest Technologies. UC, Davis, USA. 4. Peter KV. 2016. <i>Innovations in Horticulture</i>. NIPA, New Delhi. 5. Prasad S, Singh D and Bhardwaj RL. 2012. <i>Hi-Tech Horticulture</i>. Agrobios (India). 6. Tyagi, S. 2019. <i>Hi- Tech Horticulture</i>. Vols. 1 to 7. NIPA, New Delhi. 7. Zhang Q. 2017. <i>Automation in Tree Fruit production – Principles and Practice</i>. CABI. http://horticulture.ucdavis.edu- Innovative Technology for Horticultural Department.	
Recommended by the Board of Studies	02.02.2024
Approved by the Academic Council	11.05.2024

WATER INSTITUTE

LIST OF NEW COURSES

S No.	Code	Course Name	Category	L	T	P	C
1	24WI3001	Basic Principles of IWRM	PCC	3	0	0	3
2	24WI3002	Hydrological Processes	PCC	3	0	0	3
3	24WI3003	Wastewater Management	PCC	3	0	0	3
4	24WI3004	Irrigation Water Management	PCC	3	0	0	3
5	24WI3007	Water Supply Distribution and Maintenance	PCC	3	0	0	3
6	24WI3008	Water Supply Distribution Network and Quality Analysis Laboratory	PCC	0	0	4	2

Course Code	BASIC PRINCIPLES OF IWRM	L	T	P	C
24WI3001		3	0	0	3
Course Objectives:					
1. Gain understanding on the principles of IWRM and its inter-disciplinary nature.					
2. Acquaint with approaches towards sustainable water resources management, water security and public-private participation issues.					
3. Explore integrated multi-sectoral and multi-dimensional issues, role of PPP in developing water resource management plans.					
Course Outcomes:					
At the end of the course, the students will be able to:					
1. Explain the concepts and principles of IWRM in the context of three pillars of sustainability to assess water crisis.					
2. List the salient features of national water policy and relate the concepts of the river basin approach and watershed management towards sustainability.					
3. Identify and correlate the problems related to water & soil and their impacts on human and environment.					
4. Compare the effectiveness of traditional and modern techniques for water security, considering environment, society and economics.					
5. Describe the case studies of Public-Private Partnerships (PPPs) in the context of IWRM.					
6. Articulate the role and impact of IWRM framework in SDG.					
Module: 1	Concepts, Principles and Terminologies	8 Hours			
IWRM: definition and principles - Social, economic, environmental and institutional factors in water management – Water needs for human beings and nature-Concepts of ‘blue’, ‘green’ and ‘grey’ water - Ecosystem approach - Global climate change and its effect on water resources.					
Module: 2	Sustainable Water Resources Management	7 Hours			
Concept of sustainable development-Dublin Conference and Earth Summit- National Water Policy: highlights and limitations –River basin approach – Small watershed management →Environmental flows-Minimum water table.					
Module: 3	Water related Environmental and Health Problems	8 Hours			
Floods –Droughts- Soil erosion- Reservoir sedimentation-Salinity intrusion into surface and groundwater sources-Soil salinity- Waterlogging in command areas-Sand mining-Impact of population and anthropogenic activities on water resources.					
Module: 4	Traditional and Modern Techniques for Water Security	7 Hours			
Role of water in development - Rainwater harvesting – Artificial recharge – Conjunctive use of surface and groundwater-Interbasin transfer-Conservation of ‘green’ water – Treatment of ‘grey’ water- Basics of desalination and water treatment and recycling.					
Module: 5	PPP and Private Markets	8 Hours			

Introduction to water economics and governance of water utility - Water pricing - Private sector involvement in water resources management: PPP objectives, options, process and limitations-PPP case studies.		
Module: 6	IWRM in the context of SDG6	7 Hours
IWRM frame work in SDG 6 – Successful case studies for implementation of IWRM.		
Total Hours		45 Hours
Reference Books:		
1	Nicolas Spulber, Asghar Sabbaghi "Economics of Water Resources: From Regulation to Privatization", Springer, 2012.	
2	Roberto Lenton, Mike Muller "Integrated Water Resources Management in Practice: Better Water Management for Development", Earthscan, 2009.	
3	Pedro Martinez-Santos, Maite M. Aldaya, M. Ramón Llamas "Principles of Integrated Water Resources Management", IWA Publishing, 2014.	
4	Cech Thomas V., "Principles of Water Resources: History, Development, Management and Policy", John Wiley and Sons Inc., New York, 2003.	
5	Cap-Net, Tutorial on basic principles of Integrated Water Resources Management, Cap-Net, IRC, IWMI, HRWallingford, IUCN, WSS, UNDP (www.cap.net.org).	
Recommended by Board of Studies		17/07/2024
Approved by Academic Council		20/08/2024

Course Code	HYDROLOGICAL PROCESSES	L	T	P	C
24WI3002		3	0	0	3
Course Objectives:					
1. Acquire knowledge on different components of hydrologic cycle and application of hydrological models.					
2. Gain practical experience in hydrological data acquisition, analysis and interpretation based spatial and temporal scales.					
3. Comprehend the interconnections between the aquifers in the groundwater system and estimation of the aquifer parameters.					
Course Outcomes:					
At the end of the course, the students will be able to:					
1. Elaborate the role and significance of processes in hydrological cycle for estimation of water budget.					
2. Analyze the precipitation data and estimate the losses due to evaporation and evapotranspiration.					
3. Articulate the measurement techniques of streamflow and predict the peak & design flow using hydrographs.					
4. Explain the physical properties of confined and unconfined aquifers in the groundwater system.					
5. Estimate the aquifer parameters using pumping test results and analyse draw down in the wells.					
6. Describe the concepts and applications of hydrological models in water resources planning and management.					
Module: 1	Basic Hydraulics and Hydrology	7 Hours			
Overview of hydrology and its significance in water resource management - Hydrological cycle: components and processes-Conservation of mass and energy.					
Module: 2	Precipitation and Evapotranspiration	8 Hours			
Precipitation - Types of precipitation - Temporal and spatial distribution of precipitation- Measurement and analysis of precipitation, Evaporation and transpiration proceses - Estimation of evaporation using Pan Evaporimeter data-Thornthwaite and FAO Penman-Monteith methods.					
Module: 3	Runoff and Stream Flow	7 Hours			
Phenomenon of runoff-Infiltration - River and stream flow measurement techniques- Streamflow hydrograph analysis - Flow duration curves and frequency analysis					
Module: 4	Basics of Groundwater Flow	8 Hours			

Groundwater occurrence and aquifer types - Properties of aquifers - Darcy's law: groundwater velocity, hydraulic head, hydraulic conductivity and permeability - Porosity and void ratio - Transmissivity and storativity.		
Module: 5	Groundwater Hydraulics	8 Hours
Well hydraulics (confined and unconfined aquifers): Theis equation-Dupit equation-Thiem method for estimating drawdown using observation wells-Pumping test and estimation of parameters.		
Module: 6	Introduction to Hydrological Modeling:	7 Hours
Introduction to hydrological models: deterministic and stochastic models- Model calibration, validation, and uncertainty analysis.		
Total Hours		45 Hours
Reference Books:		
1	Ram S. Gupta, "Hydrology and Hydraulic Systems", Waveland Press, 2017	
2	Ven Te Chow, David Maidment, Larry W. Mays, "Applied Hydrology, 2nd Edition", McGraw-Hill Education, 2022	
3	R.C. Ward, M. Robinson "Principles of Hydrology", McGraw-Hill Education, 2016	
4	David Keith Todd, Larry W. Mays, "Groundwater Hydrology", John Wiley & Sons, 2020	
5	K. Subramanya "Engineering Hydrology", McGraw Hill Education, 2020	
Recommended by Board of Studies		17/07/2024
Approved by Academic Council		20/08/2024

Course Code	WASTEWATER MANAGEMENT	L	T	P	C
24WI3003		3	0	0	3
Course Objectives:					
1. Enhance the knowledge on analytical procedures to analyze wastewater characteristics, considering factors such as population forecasts, water demands, and wastewater quantities. 2. Equip with technical skills in the basic design, operation, and maintenance of primary, biological, and tertiary treatment processes, including advanced treatment technologies. 3. Comprehend the performance of nature based and community-based sustainable wastewater treatment systems.					
Course Outcomes:					
At the end of the course, the students will be able to:					
1. Estimate the quantity of wastewater generation and assess its physio-chemical and biological characteristics. 2. Describe the removal mechanism of settleable and floatable solids in primary unit operations based on the design parameters. 3. Apply the concepts of biodegradation and kinetics in designing the suspended and attached growth reactors for the removal of organics. 4. Explain the working principles of electrochemical and membrane technologies in removing suspended and dissolved solids. 5. Compare the performance of natural treatment systems in treating organics and inorganic pollutants 6. Elaborate the operational and monitoring aspects of waste water treatmentt plants.					
Module: 1	Introduction to Wastewater Treatment	8 Hours			
Overview of water and wastewater treatment processes - Estimation of wastewater quantity - Temporal and spatial variation in quantity of water and wastewater - Wastewater characteristics.					
Module: 2	Primary and Physical Treatment Units	7 Hours			
Introduction to physical, chemical, and biological methods-Physical unit processes: screening, commutation, grit removal, equalization, sedimentation.					
Module: 3	Biological Treatment Units	8 Hours			
Principles of Biological Treatment - Aerobic treatment: suspended growth aerobic treatment processes - Activated sludge process and its modifications - Attached growth aerobic processes: trickling filters and rotating biological contactors - Anaerobic digestion and sludge treatment.					

Module: 4	Tertiary and Advanced Treatment Units	7 Hours
Filtration-Electrochemical methods of coagulation and adsorption and ion exchange-Introduction to Membrane technologies- Water reuse and recycling.		
Module: 5	Natural Wastewater Treatment Systems	7 Hours
Stormwater Management - Ponds and lagoons - Constructed wetlands- Low-cost sanitation - Septic tanks -Soak-pits- Bioremediation basins.		
Module: 6	Operation and Real Time Monitoring of Treatment Units	8 Hours
Asset management - Operation and maintenance of treatment facilities – Introduction to monitoring and control of treatment processes using IoT based sensors and AI.		
Total Hours		45 Hours
Reference Books:		
1. S. A Abbasi and Tasneem Abbasi, "Advanced Environmental Management: Water and Wastewater Treatment", PHI Learning, 2021.		
2. Mark J. Hammer Sr and Mark J. Hammer Jr, adaptation by S.R. Maiti "Water and Wastewater Technology", Pearson India, 2019.		
3. Nelson L. Nemerow, Franklin J. Agardy, Joseph A. Salvato, adaptation by S.R. Maiti, "Environmental Engineering: Water, Wastewater, Soil and Groundwater Treatment and Remediation", Wiley India, 2020.		
4. J. K. Sharma, "Principles of Water and Wastewater Treatment", Oxford University Press, 2022.		
5. R.K. Trivedy, "Natural Wastewater Treatment Systems", New Age International, 2020.		
6. S. A Abbasi and Tasneem Abbasi, "Advanced Environmental Management: Water and Wastewater Treatment", PHI Learning, 2021.		
Recommended by Board of Studies	17/07/2024	
Approved by Academic Council	20/08/2024	

Course Code	IRRIGATION WATER MANAGEMENT	L	T	P	C
24WI3004		3	0	0	3
Course Objectives:					
1. Gain knowledge on evolution of irrigation and explore the National Water Policy and its implications on irrigation strategies.					
2. Enrich the understanding of soil-water-plant relationships and its significance in optimizing irrigation & scheduling to ensure sustainable water use.					
3. Reinforce the learning on selection of modern irrigation methods including drip and sprinkler systems for various crops, land types, climates, and soils.					
Course Outcomes:					
At the end of the course, the students will be able to:					
1. Describe the irrigation practices and techniques on agricultural productivity in India.					
2. Estimate crop water requirement, assess soil and water quality to identify suitable irrigation strategies.					
3. Elaborate the methods of water distribution in canal networks and irrigation scheduling.					
4. Classify surface irrigation methods based on the design and wetting pattern.					
5. Compare the performance of drip and sprinkler irrigation techniques in terms of water use efficiency and crop yield.					
6. Explain the practices of sustainable irrigation through water harvesting and wastewater reuse.					
Module: 1	Development of Irrigation	8 Hours			
Importance of irrigation in agriculture and its impact on development of humanity – Historical development of irrigation practices – National Water Policy vis-à-vis irrigation– Irrigation using canal, tank and groundwater.					
Module: 2	Soil-Water-Plant Relationships	7 Hours			
Soil properties affecting water movement and retention– Crop water requirement– Crop evapotranspiration: concepts and estimation methods - Soil and water quality - Soil moisture measurement techniques.					

Module: 3	Irrigation Scheduling and Management	8 Hours
Canal network and canal regulation – Methods of distribution: supply based, and demand based – Principles of irrigation scheduling– Methods of determining irrigation schedules: soil moisture, climate-based, and plant-based approaches.		
Module: 4	Surface Irrigation Methods	8 Hours
Classification of irrigation methods – Border irrigation: design parameters, evaluation and ideal wetting pattern – Furrow irrigation: design parameters, types of furrows, evaluation, ideal wetting pattern and planting techniques.		
Module: 5	Drip and Sprinkler Irrigation Methods	7 Hours
Drip irrigation: components, suitable crops and land types – Sprinkler irrigation: types, components, and suitable crops, slope, soils and climate – Case studies from India and Israel.		
Module: 6	Sustainable Irrigation Practices	7 Hours
Concepts of sustainable irrigation and integrated water management-Indices and Index - Water conservation techniques - Use of wastewater reuse and rainwater harvesting - Successful case studies on irrigation water management practices.		
Total Hours		45 Hours
Reference Books:		
1	Majumdar D. P., “Irrigation Water Management: Principles and Practices”, Prentice Hall of India, New Delhi, 2005.	
2	Dewasish Choudhary, “Irrigation Theory and Practice”, Anmol Pub., 2008.	
3	R.N. Reddy "Irrigation Engineering" Khanna Publishers, 2018.	
4	P.K. Viswanathan, M. Dinesh Kumar, A. Narayanamoorthy, "Micro Irrigation Systems in India: Emergence, Status and Impacts", Springer, 2016.	
5	M. K. Sharma, "Principles, Practices and Development of Irrigation", Jain Brothers, 2021.	
6	K. N. Tiwari & Manoj Kumar, “Advanced Irrigation Engineering”, New Age International Publishers, 2018.	
Recommended by Board of Studies		17/07/2024
Approved by Academic Council		20/08/2024

Course Code	WATER SUPPLY DISTRIBUTION AND MAINTENANCE	L	T	P	C
24WI3007		3	0	0	3
Course Objectives:					
1. Acquire the knowledge on methods of population forecasting, water supply and demand calculations to ensure adequate supply planning 2. Comprehend different layout WDNs, materials integrated with valves and fittings and hydraulic design using modeling and simulation tools 3. Explore the role of IoT and smart water supply system to optimize resource use and customer service.					
Course Outcomes:					
At the end of the course, the students will be able to:					
1. Estimate the population forecast and analyze the water samples of the selected water sources. 2. Apply the design and working principles of physio-chemical unit operations in water treatment. 3. Describe the layout of the water supply, conveyance and distribution system. 4. Determine the flow and pressure distribution in a small water distribution system using Hardy Cross method. 5. Elaborate the concepts of DMA and simulate the continuous flow in WDN using in Water GEMS 6. Explain the concepts of digitalization in the water distribution network					
Module: 1	Planning and Estimating the Components of Water Supply	7 Hours			
Sources of water and their characteristics – Types of water demand - Population forecasting - Design period and flows – Fire demand - Water quality – Characterization and standards.					

Module: 2	Water Treatment	8 Hours
Objectives and water treatment layout – Principles, functions of unit operation and processes: chemical feeding, coagulation, flocculation, filtration, disinfection and sludge management.		
Module: 3	Conveyance and Distribution	8 Hours
Intakes – Systems of water supply: continuous and intermittent system – Conveyance System – Open Channel Flow- Service reservoirs – Layout of the distribution system.		
Module: 4	Hydraulic Design of Water Distribution Network	7 Hours
Flow in pipes and flow regimes - Bernoulli equation – Friction losses – Pressure calculation – Design criteria and design of networks – Hardy cross method.		
Module: 5	Modeling and Simulation	8 Hours
Continuous (24*7) water supply systems – District Metered Areas (DMA) for zoning – Introduction to EPANET / WaterGEMS for the design of water distribution network.		
Module: 6	Digital Water Supply System	7 Hours
Concept of smart water supply system – Introduction to IoT and sensing devices in water supply – Smart metering and water pricing.		
Total Hours		45 Hours
Reference Books:		
1	Warren Viessman Jr., Mark J. Hammer, Elizabeth M. Perez, Paul A. Chadik, "Water Supply and Pollution Control" (8th Edition), Pearson, 2017.	
2	Dr. B.C. Punmia, Ashok K. Jain, Arun K. Jain "Water Supply Engineering: Environmental Engineering Volume 1" (Revised Edition), Laxmi Publications, Year: 2016.	
3	Larry W. Mays, "Urban Water Supply Handbook", McGraw-Hill Education, 2019.	
4	Kerry J. Howe, John C. Crittenden, R. Rhodes Trussell, David W. Hand, George Tchobanoglous "Principles of Water Treatment", John Wiley & Sons, 2018.	
5	G.S. Birdie and J.S. Birdie "Water Supply and Sanitary Engineering", Dhanpat Rai Publishing Company, Year: 2018.	
Recommended by Board of Studies		17/07/2024
Approved by Academic Council		20/08/2024

Course Code	WATER QUALITY AND WATER DISTRIBUTION NETWORK ANALYSIS	L	T	P	C
24WI3008		0	0	4	2
Course Objectives:					
1. Gain a thorough understanding of the components and design principles of water supply distribution networks. 2. Explore various techniques for analyzing the quality of water, including chemical, physical, and biological assessments. 3. Acquire hands-on skills in operating laboratory equipment for laboratory projects, including collecting data, and result analysis.					
Course Outcomes:					
1. Classify different components of water distribution network. 2. Develop skills in operating the pilot scale water distribution network. 3. Evaluate the performance of a small water distribution network using EPANET/WaterGEMS. 4. Identify the losses due to leakage and pressure in the water distribution network. 5. Analyze water quality parameters and their impact on public health and safety. 6. Determine the bulk chlorine decay coefficient in the water distribution pipes.					
Water sampling					
1. Preservation-insitu analysis					
Physical and Chemical Analysis of Water and Wastewater Quality					
2. pH, Conductivity, Total Dissolved Solids					
3. Chloride, Sulphate, Nitrate					
4. Hardness					

5. Iron, Manganese(spectrophotometry), 6. <i>E-Coli</i> and Total coliforms 7. Chlorine demand 8. Bulk chlorine decay coefficient 9. Hydraulic analysis of water distribution 10. Pressure and leakage detection	
Total Hours	60 Hours
Reference Books:	
1	Water Distribution Operator Training Handbook, Fourth Edition, AWWA, 2014.
2	Prabhata K. Swamee, Ashok K. Sharma, Design of Water Supply Pipe Networks, John Wiley & Sons, 2008.
3	“Standard Methods for the Examination of Water and Wastewater”, 14 th ed, American Public Health Association, Washington, DC.
4	Vogel, A.I., “Inorganic Quantitative Analysis”, - VI Edition, Prentice Hall Inc., 1998.
5	Sawyer, C.N., McCarty, P.L., and Parkin, G.F.,” Chemistry for Environmental Engineers”, IV Edition, McGraw Hill, New Delhi, 1994.
Recommended by Board of Studies	17/07/2024
Approved by Academic Council	20/08/2024

**SCHOOL OF
AGRICULTURAL SCIENCES**

LIST OF NEW ELECTIVE COURSES

S. No.	Discipline	Course Code	Name of the Course	Credits
1	AEC	23AG2057	Agribusiness Management	3(2+1)
2	GPB	23AG2205	Commercial Plant Breeding	3(1+2)
3	HOR	23AG2275	Food Safety and Standards	3(2+1)
4	SAC	23AG2309	Biopesticides & Biofertilizers	3(2+1)
5	AEG	23AG2454	Protected Cultivation	3(2+1)
6	HOR	23AG2276	Micro propagation Technologies	3(1+2)
7	HOR	23AG2277	Hi-tech. Horticulture	3(2+1)
8	AGR	23AG2012	System Simulation and Agro-advisory	3(2+1)
9	AEX	23AG2126	Agricultural Journalism	3(2+1)

23AG2109 EXPERIENTIAL LEARNING PROGRAM-SEED PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Process of filing the application for certified classes of seed production .
2. Different stages and activities required to be undertaken for seed certification.
3. Seed networking channels in Private and Public sector seed companies.

Course Outcomes

On completion of this course, students will be able to:

1. Produce quality seeds with prescribed seed standards fixed by International Seed Testing Association (ISTA).
2. Carry out all operations as required by the Agricultural Officer to maintain genetic purity and obtain Seed certification.
3. Gain hands-on experience in seed production and certification.
4. Understand and practice the techniques of seed processing, packaging and labelling.
5. Identify the marketing channels and challenges in seed production.
6. Gain the confidence to initiate Seed Business ventures.

Planning of seed certification procedures, application for seed license, preparation of field map for registration and field layout, assessment of seed source, designing of planting ratio, seed upgradation, visit to Seed Certification Department, sowing, field inspection, rouging operations, foliar application of nutrients, pollen management and assessment of seed set, visit to seed production plot. Pre-harvest sanitation spray, determination of maturity, harvesting, post-harvest verification, preparation of processing report. Drying, processing sequence, application for getting approval of seed processing unit, sampling and submission of samples, pre-storage seed treatments and packing, tagging, economics of seed production, visit to seed testing laboratory for seed testing, visit to private seed industry to study seed marketing network, seed export and import.

Textbooks

1. Agrawal, R.L. (2012). *Seed Technology*, Oxford & IBH Publishing Co., New Delhi.
2. Trivedi, R.K. and M. Gunasekaran. (2013). *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.

References

1. Ramalingam, C., K. Sivasubramaniam and A. Vijayakumar. (1997). *A guide to seed legislation*. Rasi Computers, Madurai.
2. <https://seednet.gov.in/PDFFILES/Certification Process.pdf> .
3. https://agricoop.nic.in/sites/default/files/indian_minimum_seed_certificationstandards.pdf
4. <https://www.en.krishakjagat.org/Vibrant and dynamic seed sector in India: Key highlights, challenges and opportunities>
5. <https://www.seedworld.com/Beginners Guide to Importing and Exporting Seed - Seed World>

23AG2110 EXPERIENTIAL LEARNING PROGRAM-SOIL, PLANT, AND WATER TESTING SERVICES

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Soil sample collection, determination of physico-chemical parameters and nutrient content and inferring the fertility status of the soil.
2. Determination of the quality of irrigation water in relation to its suitability for irrigation.
3. Estimation of plant nutrient content, preparation of soil health cards and water test reports.

Course Outcomes

On completion of this course, students will be able to:

1. Conduct soil, plant and water sampling and process these samples for analysis.
2. Estimate the physico-chemical soil parameters, macro and micronutrient contents and infer the fertility status.
3. Analyse the macronutrient and micronutrient content in the plant samples.
4. Prepare soil health cards along with fertilizer recommendation based on the nutrient status of the soil for the crops raised by the farmer.
5. Prepare water test reports and infer on the suitability of the water for irrigation.
6. Start up a soil and water testing unit and advisory centre.

Collection and preparation of soil, plant and irrigation water samples (sampling, processing and storing), estimation of pH, EC, organic carbon, available nitrogen, phosphorus, potassium and micronutrients – available Fe, Mn, Cu and Zn in soil, inferring the results and evaluating the fertility status of the soil.

Plant sample preparation for analysis, digestion of plant material and estimation of Nitrogen, Phosphorus and Potassium in plant. Determination of pH, EC, carbonate and bicarbonate, calcium, magnesium, sodium and potassium content in irrigation water. Computation of irrigation water quality, Residual Sodium Carbonate (RSC) and Sodium Absorption Ratio (SAR) of Irrigation water and evaluating the suitability of irrigation water.

Textbooks

1. Brady, N. C., and R. R. Weil. (2017). *The Nature and Properties of Soils*, The, 15th Edition. Pearson, Upper Saddle River, N.J.
2. Muthuvel, P. and C. Udayasoorian. (1999). *Soil, plant, water and agrochemical analysis*, Tamil Nadu Agricultural University, Coimbatore, India.

References

1. Ali, Tahir and Ab Shakoor Khanday (2018). *Soil, plant water and agro-chemical analysis*. Satish Serial Publishing house, Delhi.
2. Black, C. A. (1982). *Methods of Soil Analysis*, Part I ASA, Madison, USA.
3. Havlin, L., Samuel, L.T., Werner L. N. and J. D. Beaton. (2013). *Soil Fertility and Fertilizers: An Introduction to Nutrient Management*, 8th Edition, Pearson Education Inc., USA.
4. Hesse, P. R. (2002). *A Textbook of Soil Chemical Analysis*, CBS Publishers and distributors, Delhi.
5. John L. H., Samuel L. T., Werner L. N. and J. D. Beaton. (2016). (8th Edn). *Soil Fertility and Fertilizers*. Pearson Publishers. London.

23AG2111 EXPERIENTIAL LEARNING PROGRAM-ORGANIC PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Organic production protocols and requirements for certification.
2. Organic inputs and crop production through hands-on experience.
3. Project management skills in organic inputs and crop production.

Course Outcomes

On completion of this course, students will be able to:

1. Develop knowledge and skill on the production techniques of various organic manures, bio-pesticides and bio-control agents.
2. Gain insight on protocols for organic crop production technologies from seed to seed.

3. Acquire skills in the use and application of various organic manures, bio-pesticides and bio-control agents.
4. Earn hands on experience in vermicompost production and organic green leafy vegetable cultivation.
5. Independently guide farmers on organic certification protocols and marketing.
6. Build confidence to initiate startup ventures in organic crop production.

Principles of composting. Various methods of composting. Characterization and preparation of quality compost material. Study of earthworms and methods of vermicomposting and preparation of bio-compost. Enriched compost and ITK based biological preparations. Visit to compost/vermicompost production unit. Preparation and use of bio-pesticides and bio-control agents. Quantification of nutrients from organic sources. Keeping quality - Application methods of manures and bio-fertilizers. Toxic residue analysis. Visit to bio-pesticides and bio-control production unit. Raising organic nursery and green manures for agricultural crops - Raising of crops organically by using organic inputs. Weed management – Nutrient management. Pest and disease management. Grading, packaging, post-harvest management and certification process. Visit to organic farms, organic farming outlets and certification agencies to study the standards & certification process.

Textbooks

1. Palaniappan S. P. and K. Annadurai. (2018). *Organic Farming: Theory and Practice*. Scientific Publishers, Jodhpur, India.
2. Reddy, S. R. (2017). *Principles of Organic Farming*, Kalyani Publishers, New Delhi.

References

1. Parvatha, R. P. (2010). *Organic farming for sustainable Horticulture*. Scientific Publishers, Jodhpur, India.
2. Panda, H. (2007). *Biofertilizers and Organic Farming*. Ed. Dharamvir Hota. Gene-Tech Books.
3. Ann. L.H. (2010). *Organic Farming Manual: A Comprehensive Guide To Starting And Running A Certified Organic Farm*, Storey Publishing LLC. MASS MoCA, USA.
4. Sharma, A. K. (2008). *Hand book of Organic Farming*. Agrobios, Jodhpur, India.
5. Tarafdar, J. C., Tripathi K. and M. Kumar. (2009). *Organic Agriculture*. Scientific Publishers, Jodhpur, India.

23AG2112 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL FLORICULTURE AND LANDSCAPING

Credits (0+10)

Course Objectives

To impart knowledge on:

1. The principles and methods of flower crop production and landscape gardening.
2. Various post-harvest technologies and value addition of flower crops.
3. Entrepreneurship skills in floriculture and landscape gardening.

Course Outcomes

On completion of this course, students will be able to:

1. Gain hands-on experience in commercial cultivation of flower crops.
2. Professionally design and develop styles and types of gardens.
3. Acquire skills on improving vase life of cut flower crops.
4. Develop value-added products using fresh and dry flowers.
5. Enhance their business networking skills and marketing channels of value-added flower products.
6. Promote startups and business ventures in floriculture and landscaping.

Scope and importance of commercial floriculture in India. Growing of commercial flowers under protected structures – polyhouse, shade nethouse. Preparation of land and layout. Production techniques of commercial flower crops for domestic and export market. Principles of landscaping- Study of different types and styles of gardens. Designing and planting for establishing different landscape gardens. Postharvest technology of cut and loose flowers. Transportation for local and export market. Study of supply chain management and cold storage techniques. Dehydration techniques for drying of flower (identification of suitable species, drying and packaging). Development and marketing of various flower products (fresh & dry). Visit to

different landscape like public, institutional, industrial and botanical gardens. Preparation of cost analysis and report writing.

Textbooks

1. Kumar, A. and A. Kumar (2019). *Textbook On Commercial Floriculture and Ornamental Horticulture with Landscape Architecture*. Kalyani Publishers, New Delhi.
2. Singh, A. K. and Anjana. S. (2020). *Textbook of Floriculture and Landscaping*. New India Publishing Agency, New Delhi.

References

1. Barnett, F. (2020). *The Ultimate Book of Fresh & Dried Flowers: A Complete Guide to Floral Arranging*. Hermes House, Pennsylvania.
2. Datta, S. K. and Gupta, Y. C. (2022). *Floriculture and Ornamental Plants*. Springer Nature, Germany
3. Desh, R. (2020). *Floriculture at A Glance* (Latest Edition). Kalyani Publishers, New Delhi.
4. Mishra, P. and B. Naik (2022). *Principles of Landscape Architecture*, New India Publishing Agency, New Delhi.
5. Shivani, S., Garima, K. and K. Poonam (2021). Standardizing dehydration techniques for ornamental foliage plants. *Journal of Ornamental Horticulture*. 24(2): 136- 142.

23AG2113 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL NURSERY MANAGEMENT AND PROTECTED CULTIVATION

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Propagation and planting techniques of Horticulture crops under open and protected conditions
2. Procurement, seed production and development of progeny orchards of elite planting material
3. Commercial nursery establishment & production, and developing entrepreneurial skills

Course Outcomes

On completion of this course, students will be able to:

1. Gain hands-on experience on selection of planting materials and propagation for commercial nursey production of Horticultural crops
2. Learn the various aspects in procurement of inputs including seeds, mother plants, pots and potting media and other accessories in a cost-effective manner
3. Gain experience in improved methods of mass production of selected high value Horticultural crops
4. Achieve skills in the use of modern technologies such as foggers, misting units, timers, sensors, and fertigation units under protected/ open condition
5. Manage pest and diseases in nurseries
6. Develop business networking and entrepreneurship skills for promoting sales of nursery plants.

Nursery production of fruit crops: Procurement of seeds and raising of rootstocks, identification of scion source of elite varieties – precuring of scions, grafting and budding with suitable rootstocks. Assessment of graft and bud union – removal of rootstock sprouts, management of grafted and budded plants. Nursery production of ornamental plants and trees. Seeds and seedling production of vegetable and ornamental plants. Raising of greens and annual flower crops, harvest and sale of value - added products like flower bouquet. Multiplication of potted plants, management practices like regular watering, removal of dry and dead tissues, plant protection and foliar nutrition. Use of tools, equipment. Nursery maintenance and input management: Procurement of different types of pots and plantlets, collection of seeds of ornamental trees from available sources, preparation of potting mixtures using coir pith, red soil, sand, FYM and vermicompost. Working out cost economics and report writing. Visit to commercial plant nurseries.

Textbooks:

1. Deepa, H. D. and N. Bharti (2018). *A handbook for skill development - Nursery management of Horticultural crops*, Satish Serial Publishing House, New Delhi.
2. Ranjankumar, T. (2020). *Plant propagation and nursery management*, New India Publishing Agency, New Delhi.

References:

1. Hartmann, H. T., Kester, D. E., Davies, F.T. and R.L. Grene (2010). *Plant Propagation –Principles and Practices*. Prentice Hall of India Private Ltd., New Delhi.

- ICAR, (2013). Resource book on Horticulture Nursery Management, National Agricultural Innovation Project, Indian Council of Agricultural Research, New Delhi.-110012.
- Prasad, S. and U. Kumar (2005). *Green house management for horticultural crops*. 2nd ed. Agrobios.
- Ratha Krishnan, P. (ed.) (2014). *Plant nursery management: Principles and practices*, Central Arid Zone Research institute, ICAR. Evergreen Printers, Jodhpur.
- Ray, P. K. (2021). *Essentials of plant nursery management* 2nd edition, Scientific Publisher.
- Tiwari, G. N. (2003). *Green house technology for controlled environment*. Narosa Publishing House. New Delhi.

23AG2114 EXPERIENTIAL LEARNING PROGRAM-PRODUCTION TECHNOLOGY OF BIOFERTILIZER

Credits (0+10)

Course Objectives

To impart knowledge on:

- Professional skills through hands on experience on biofertilizer production.
- Maintenance of aseptic conditions, laboratory equipment and subculturing various bioinoculants.
- Quality control and Standards of biofertilizers for sustainable crop production.

Course Outcomes

On completion of this course, students will be able to:

- Isolate and conserve the efficient strains of microorganisms for the improvement of plant growth and soil health.
- Familiarize with the routine handling of equipments used in biofertilizer production unit.
- Acquire hands on experience on commercial production technologies of various biofertilizer formulations.
- Practise the skills and procedures in quality control of biofertilizers.
- Apply the bio-inoculants as per package of practices recommended in organic farming and crop production.
- Attain technical, marketing and entrepreneurial skills to establish a biofertilizer startup\ unit.

Isolation, characterization, screening and pure culture establishment of bio-fertilizers and bio-pesticides. Commercial mass production of bio-fertilizers. Quality analysis of bio-fertilizers. Testing the final product in small-scale level. Storage, marketing and cost analysis of biofertilizers.

Textbooks

- Amitava, R., Vijay, M., Manoj, P, Singh, H.B. and A .K. Singh. (2021). *Biofertilizers. Volume 1: Advances in Bio-inoculants* (1st Edition) Woodhead Publishing. Elsevier.
- Rai, M. K. (2006). *Handbook of Microbial Biofertilizers*. Food Products Press®, Binghamton, NY.

References

- Chandarana, K.A. and N. Amaresan (2023). *Rhizobium Biofertilizers: Mass Production Process and Cost-Benefit Ratio Analysis*. In: Amaresan, N., Dharumadurai, D., Babalola, O.O. (eds) *Agricultural Microbiology Based Entrepreneurship . Microorganisms for Sustainability*, vol 39. Springer, Singapore.
- Gouda, S., Kerry, R. G., Das, G., Paramithiotis, S., Shin, H. S. and J. K. Patra. (2018). Revitalization of plant growth promoting rhizobacteria for sustainable development in agriculture. *Microbiological Research*, 206, 131–140.
- Glick, B.R. (2015). *Introduction to plant growth-promoting bacteria*. In : Glick, B.R. (Ed.), *Beneficial Plant-Bacterial Interactions*. Springer International Publishing Switzerland, pp.1–28.
- Mishra, J. and N. K. Arora. (2016). *Bioformulations for plant growth promotion and combating phytopathogens: A Sustainable Approach*. In: Arora, N. K., Balestrini, R., Mehnaz, S. (Eds.), *Bioformulations: For Sustainable Agriculture*. Springer India, pp.3–33.
- Raja, N. (2013). Bio pesticides and biofertilizers: eco -friendly sources for sustainable agriculture. *J. Fertil. Pestic.* 4,1–2.

23AG2115 EXPERIENTIAL LEARNING PROGRAM-MUSHROOM CULTIVATION TECHNOLOGY

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Importance of mushrooms and its nutritional value.
2. Hands on training to the students for the preparation of beds for different varieties of mushroom and spawn production.
3. Product diversification, value addition of mushrooms and cost economics of mushroom cultivation.

Course Outcomes

On completion of this course, students will be able to:

1. Identify and differentiate edible and poisonous mushrooms.
2. Gain hands on experience in cultivation of different types of edible mushrooms and spawn production.
3. Identify and manage various biotic and abiotic factors that reduce the yield of mushroom.
4. Prepare value-added products of mushrooms.
5. Apply market intelligence and support systems to realise maximum yield and profit.
6. Develop entrepreneurial skills leading to start ups and business ventures.

Students will learn the facilities required for construction of mushroom shed, cultivation room/structure and disinfection, maintenance of aseptic condition. Learn cultivation techniques for oyster mushroom: procurement of mother culture and spawn preparation - sterilization of straw- bed preparation – mushroom seeding – moisture maintenance – harvesting. Learn cultivation techniques for milky mushroom compost preparation and pasteurization - procurement of mother culture and spawn preparation - procurement of casing soil and preparation for production -mushroom seeding - casing with soil and maintenance – harvesting. - Value added processing - Grading, packing - marketing and Cost economics of mushroom culture. Exposure visit to mushroom cultivation units.

Textbooks

1. Aggarwal, A., Sharma, Y.P. and E. Jangra (2021). *A Textbook on Mushroom Cultivation: Theory and Practice*. Newrays publishing House, New Delhi, India.
2. Pathak,V. N., Yadav, N. and M. Gaur (2020). *Mushroom production and processing Technology*. Agribios (India) Ltd., New Delhi, India.

References

1. Gupta, S., Summuna, B., Gupta, M. and S.K. Annepu, (2018). Edible mushrooms: cultivation, bioactive molecules, and health benefits. *Bioact. Mol. Food*, 1:1-33.
2. Pandey, V.V., Kumari, A., Kumar, M., Saxena, J., Kainthola, C. and A. Pandey (2018). Mushroom cultivation: Substantial key to food security. *J. Appl. Natural Sci.* 10(4):1325-1331.
3. Sarita, S.S., Yadav, K. and A.K.Sharma (2022). Studies on Standardization of Production Technology of Oyster Mushroom. *Eco. Env. Cons.* 200-204
4. Shirur, M., Shivalingegowda, N.S., Chandregowda, M.J. and R.K.Rana. (2016). Technological adoption and constraint analysis of mushroom entrepreneurship in Karnataka. *Econ. Aff.* 61(3):427-436.
5. Thakur, M.P. (2020). Advances in mushroom production: key to food, nutritional and employment security: A review. *Indian Phytopathol.* 73:377-395.
6. Yaeger, W., Jawed, M., Tauman, D., Ho, P., Ali, A., Gomanie, N.N. and Mehta, K. (2022). September. Modular methods for oyster mushroom cultivation in low-resource settings. In 2022 *IEEE Global Humanitarian Technology Conference (GHTC)* (pp. 30-37). IEEE.

23AG2116 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL BEEKEEPING

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Various techniques of beekeeping, types of honeybees, apiary management, nutraceutical properties of honey and by-products, pest and disease management.
2. Migratory/ stationary beekeeping, harvesting and processing of honey, product diversification and value addition of honey and beeswax, quality control, standards and marketing.
3. Beekeeping entrepreneurship – to initiate start-ups, consortia and co-operatives.

Course Outcomes

On completion of this course, students will be able to:

1. Familiarize with bee biology, behaviour, and rearing of bees.
2. Gain hands-on experience in handling of beekeeping equipment such as hives, honey extractor, and tools.
3. Develop experience in beehive management- Manage pests, diseases, and invasions to beehives.
4. Gain expertise in extraction, preservation, marketing, and quality assessment of honey and other by-products.
5. Practise migratory beekeeping for ensuring commercial honey production and collection around the year and develop as a commercial beekeeper.
6. Develop value-added products for commercialization.

Familiarization with different honeybee species and different castes of honeybee. Handling of frames with colonies. Identification and selection of bee flora - propagation of bee plants - preparation of floral calendar - hiving feral Indian bee colony, site selection for the apiary. Visit to migratory beekeeping sites and commercial *Apis cerana* bee farm. Visit to innovative manufacturing units, processing units and societies. Colony inspection, maintenance - write up of inspection report. Identification of queen, drone and brood cells - artificial feeding of colonies during scarce periods - Identification of swarming tendency in a colony. Removal of Drone cells - maintenance of hive record -Management in honey flow season, dearth period, management of swarming, absconding, and laying workers -Practicing the methods of multiplication of bee colonies - Dividing, uniting bee colonies - Disease management - Identification of symptoms of Nosema, Sac brood Virus, Thai sac brood virus, American foulbrood, and European foulbrood diseases - Preventive and control measures of the disease management- Antibiotics in disease management –Practicing the disinfection of frames - Natural enemies and predators of honeybees and their management. Migratory Bee Keeping – Protocols to be ensured while transporting colonies - Mapping of areas for migration. Extraction of honey using honey extractor - moisture reduction - packing and storing of honey- methods of extraction of beeswax, royal jelly, and bee venom -quality standards. Marketing and marketing channels - Economics of honey and bee products – Preparation of Project proposal on beekeeping and honey processing unit for entrepreneurial development- Honey testing kit - physical and chemical methods of analysis - Visit to AGMARK laboratory.

Textbooks

1. David, B. V. and V. V. Ramamurthy. (2017). *Elements of Economic Entomology: 8th Edition*. Brillion Publishing, New Delhi.
2. Ragumoorathi, K.N., M. R. Srinivasan, and V. Balasubramani. (2022). *Principles of Applied Entomology: 3rd Edition*. Asha Books House, India.

References

1. Abrol, D.P. (2011). *Beekeeping- A comprehensive guide to bees and beekeeping*. Scientific publishers. Jodhpur.
2. Belsare, D. K., Rakesh Kumar Singh, D. B. Shashikala, and R. H. Deshmukh. (2019). *Textbook of Apiculture (Beekeeping)*. Himalaya Publishing House, Mumbai.
3. David Cramp. (2012). *The Complete Step-by-step Book of Beekeeping: A Practical Guide to Beekeeping, from Setting up a Colony to Hive Management and Harvesting the Honey*. Lorenz Books. London.
4. Kim Flottum. (2014). *The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden*. Quarry Books.
5. SuganyaKanna, S., T. Senguttuvan and P. Karthik. (2019). *Management of beneficial and harmful insects*. Guru Publishers, Trichy.
6. Vijay Kumar Kaushik. (2012). *Beekeeping In India A Profitable Enterprise*. Jain Brothers, New Delhi.

23AG2117 EXPERIENTIAL LEARNING PROGRAM-AGRIBUSINESS MANAGEMENT

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Assessing the supply, demand, and price trends of agricultural commodities.
2. Creating an app to launch a digital platform for the sale of agricultural commodities.

3. Pursuing a career as a business consultant

Course Outcomes

On completion of this course, students will be able to:

1. Carry out market survey and understand consumer behaviour, demand and supply of agricultural commodities and price trends
2. Creating an app to launch a digital platform for the sale of agricultural commodities.
3. Design a customized digital marketing plan.
4. Gain the necessary entrepreneurial skills to successfully initiate a start-up /agri- business venture.
5. Develop skills in commodity trading, website design, creation and hosting, and use of social media platforms for marketing.
6. Prepare a business project proposal to financial institutions.

Agribusiness landscape in India: Economic – Political – Institutional Ecosystem for Agribusiness. Market survey: Consumer profile, competitors, substitutes and their price and features, forecasting market demand, pricing methods, creating and organizing advertising campaigns - Facebook ads, twitter ads, etc. Management of Agro-Inputs – Visits to Marketing Firm and Government Institutions. Product management: Various packaging materials used for agro-based products, product distribution network, marketing cost and marketing planning process, Commodity trading, marketing research and devising marketing strategies, Information system for new product development, options for extending Product Life Cycle (PLC), Spot and Online marketing - Social media marketing via YouTube, Facebook, Twitter, Instagram, and Pinterest. Export-import policies followed by agriculture marketing firms. Business Law and Ethics: Law of contracts, Companies act, Consumer Protection Law, Business Ethics. Preparation of a model Project Proposal and Financial Statements - Balance Sheet, Income statement and cash flow statement.

Textbooks:

1. Acharya, S.S and Agarwal. N L. 2019. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Raju, V.T. and D.V.S. Rao. (2014). Economics of Farm Production and Management. Oxford and IBH Publishers, New Delhi.

References

1. Bagavathi, V and Pillai, R.S.N (2007). Business law. S.Chand and Company Ltd, New Delhi.
2. Chavan, U.D. Patil J.V, Pawar.P.P, Shinde, H.R, Nawadkar.D.S and Nimbalkar.C.A (2015) Key Notes on Agricultural Economics, Business Management and Statistics (PB), Daya Publishing House, New Delhi.
3. Fernando, A.C, Muralidheeran, K.P and Satheesh. E.K. (2019). Business Ethics: An Indian Perspective, Pearson Education, London.
4. Patil J. V., H.R. Shinde, Chavan, and P.P. Pawan. (2015). Key Notes on Agricultural Economics, Business management and statistics, Astra e-book publication.
5. Sharma, Pawan Kumar, Dwivedi, Sudhakar and Bhat Anil. (2014). Practicals in Agricultural Economics, Daya Publishing House, New Delhi.

23AG2118 EXPERIENTIAL LEARNING PROGRAM-AGRICULTURAL INFORMATION SUPPORT SERVICES

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Information and Communication Technologies (ICTs) based agriculture information services to stakeholders.
2. Content Management Systems (CMS) for dissemination of weather information and advisory services.
3. Hands-on training to students on Agriculture Expert System and Decision Support System.

Course Outcomes

On completion of this course, students will be able to:

1. Become familiar with tools for agriculture information dissemination.
2. Develop websites for agriculture information services to agriculture stakeholders.
3. Design Mobile Apps for agriculture information exchange.
4. Create applications for weather information exchange with farmers.
5. Developing and testing farmer-friendly agriculture expert systems.

6. Apply Decision Support system in smart farming.

E-Agriculture and Use of ICT in Agriculture- practical applications, Online Agriculture Support Systems, Smartphone Apps (AI-based tools) for farm advisor services- pest and disease management, postharvest management etc., Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System.

Textbooks:

1. Annamaria C., Gabriele B., Raj K., Abdul, M., Dimitrios M. and O. Naud. (2020). *Agricultural Internet of Things and Decision Support for Precision Smart Farming*. 1st Edition.
2. Handbook of Agriculture. (2018). ICAR, New Delhi.

References

1. Rajni. J. and S. S Raju. (2016). *Decision Support System in Agriculture*. Paperback – 1 January.
2. Mahapatra S.K. (2019). *Introductory Agri- _Informatics*. Jain Brothers, New Delhi.
3. Vanitha G and Kalpana M. (2011). *Agro-Informatics*. New India Publishing Agency, New Delhi.
4. Saravanan. R. (2010). *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*. Hardcover – 15 June.
5. Stafford J. V. (2007). *Precision Agriculture '07*. Wageningen Academic Publishers, The Netherlands.

23AG2119 EXPERIENTIAL LEARNING PROGRAM-BROILER PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Benefits and purpose of Broiler production.
2. Setting up a broiler farming unit.
3. Management practices of poultry farm.

Course Outcomes

On completion of this course, students will be able to

1. Demonstrate the significance of broiler production.
2. Design the poultry house.
3. Carry out the brooding of chicks and ensure optimal environmental conditions such as temperature, light intensity, moisture level, ventilation etc.
4. Practise scientific feeding program based on the growth stages of chick and maintain clean and healthy environment in and around the farm.
5. Identify the common diseases and carry out prophylactic and preventive measures to be adopted in a poultry farm.
6. Processing and marketing of broiler meat.

Project preparation and planning based on visit to commercial broiler farms. Preparation of project module based on source of finance, market information, assessment of fixed and working capital requirements, identification of sources for procurement of chicks, feed and other raw materials. Setting up a broiler farming unit with suitable necessities. Planning and execution of management practices of poultry farm viz. Site selection and preparation of poultry house, different housing regimes, fumigation, incubation, brooding, debeaking and sanitation, hatching of eggs, management of chicks, management of pullets and growers, management of broilers, selection and culling, feed and feed formulation. Prevention and control of diseases: medication and vaccination. Biosecurity measures: processing of broilers, record maintenance, integration method of broilers marketing, marketing channels in broilers. Economics of broiler farming.

Textbooks

1. Banerjee, G.C. (2018). *The Text Book of Animal Husbandry*. Oxford Book Company, Calcutta.
2. Vegad J. L. (2018). *Poultry Diseases A Guide for Farmers and Poultry Professionals*. CBS Publishers & Distributors Pvt Ltd., New Delhi.

References

1. Satapathy D., A. Sharma, J.K. Paswan, S. Sarkar and T.K. Varun. (2017). *Economic Broiler Framing: Scope and Limitations*. Indian Farmer, 4(5), pp. 393-405.

2. Kumar R.K., G.R. Manjunatha and B. Chandra. (2017). *Economic performance of Contract Broiler Farming*. Indian Journal of Poultry Science, 52(2), pp. 217-221.
3. Karthikeyan, R. and V.R. Nedunchezian. (2013). *Vertical integration paving way to organized retailing in Indian poultry industry*. International Journal of Business and Management Invention 2(1): 39-46.
4. Sridharan, A. and R. Saravanan. (2013). *A Study on motivating factors to enter into poultry farming with special reference to Suguna broiler contract farms in Coimbatore district*. International Journal of Marketing, Financial Services & Management Research 2(4):109
5. Sabel Guerrero-Legarreta. (2010). *Handbook of Poultry Science and Technology*. John Wiley & Sons, New York.
6. Handbook of Animal Husbandry (2002), ICAR, New Delhi.

23AG2120 EXPERIENTIAL LEARNING PROGRAM-FOOD PROCESSING

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Various processing methods and value addition of fruits, vegetables, and cereals.
2. Hygiene, protocols, operation and use of post-harvest machineries, instruments, tools and equipment.
3. Unit processes, development of value-added products and establishment of a food processing unit.

Course Outcomes

On completion of this course, students will be able to:

1. Understand the methods and processes of food preservation and value-addition of fruits, vegetables and cereals.
2. Operate and use post-harvest machineries, instruments, tools and equipment.
3. Prepare various value-added products from fruits, vegetables and cereals and hands-on experience in storing, packaging and labelling.
4. Gain experience in quality control and standards of value-added products.
5. Develop business networking and entrepreneurial skills in marketing of processed foods.
6. Independently establish and manage a food processing unit.

Guidelines for setting up a processing unit, acquaintance with equipment used in food processing units, analysis of quality parameters in fruits and vegetables. Post-harvest treatments in fruits and vegetables, sorting, grading and sizing of fruits and vegetables, primary processing, secondary processing, packaging of food materials, Cold preservation by lyophilization. Preparation of dehydrated fruits and veggies, fruit bars Value addition: preparation of fermented beverages - wine and vinegar and preparation of non-fermented beverages – RTS beverage, nectar and squash, Preparation of intermediate moisture foods – jam, jelly and marmalade. Preservation by sugar – candies, Preservation by salt – pickle, chutneys and sauce, Minimal processing of fruits and vegetables. Preparation of baked products – cakes, cookies and bread, Visit to food processing units.

Text books

1. Huijs, M. (2022). *Food Processing: Advances in Research and Applications*. Nova Science Publishers, 196p.
2. Naik, H. R. and Amin, T. (2021). *Food Processing and Preservation*. CRC Press, 182p.

References

1. Fellows, P. J. (2022). *Food processing technology: principles and practice*. Woodhead publishing, Cambridge, United States. 765p.
2. Morris, T.N. (2004). *Principles of Fruit Preservation*. Biotech Books, Delhi. 81-7622-116-3.
3. NABARD (2014). Model project report on fruit and vegetable processing unit. www. Nabard.org.
4. Rathore, N. S., G.K. Mathur and S.S. Chasta. (2012). *Post-Harvest Management and Processing of Fruits and Vegetables*. The Energy And Resources Institute.
5. Senorans, F. J., Ibanez, E. and A. Cifuentes. (2003). New trends in food processing. *Critical reviews in food science and nutrition*, 43(5), 507-526.
6. Srivastava, R. P. and S. Kumar. (2002). *Fruit and Vegetable Preservation: Principles and Practices*. International Book Distributing Co., Lucknow.

23AG2121 EXPERIENTIAL LEARNING PROGRAM-PRODUCTION TECHNOLOGY OF BIOCONTROL AGENTS

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Significance, role and mode of action of bio-agents used in plant disease and pest management.
2. Mass production technologies for fungal, bacterial bio-control agents, predators and parasitoids.
3. Quality control, field application, regulation, cost analysis and marketing of bio-agents.

Course Outcomes

On completion of this course, students will be able to:

1. Apply the use of bio-agents for the management of pest and disease in field conditions.
2. Familiarise with mass production and quality control protocols of bio-agents.
3. Gain experience in relation to mode of action, predatory potential, parasitism of bio-agents and its scheduled application at various stages of infestation.
4. Apply and initiate procedures for registration of bio-agents as per the statutory guidelines.
5. Analyse and adopt different market intelligence and channels for production and promotion of bio-control agents.
6. Develop start-ups of bio-control units.

Students will learn about rearing of host insect *Corcyra cephalonica*. Rearing of egg parasitoid-sterilizing the host eggs and parasitization, Tricho card preparation and storing. Rearing of larval parasitoid Bracon and *Goniozus nephantidis* – sandwich method. Mass production of predator *Chrysoperla carnea*. Isolation, characterization, screening and pure culture establishment of bio-agents. Commercial mass production of bio-agents. Quality analysis of bio-agents. Testing the final product in small-scale level. Storage, marketing and cost analysis of bio-agents. Exposure visit to bio-control units.

Textbooks

1. Andow, D.A. ed. (2019). *Ecological interactions and biological control*. CRC Press.
2. Fouda, H. S. (2019). *Biological control of insects, pests and diseases*. Arcler Education Inc.

References

1. Fira, D., Dimkić, I., Berić, T., Lozo, J. and S. Stanković (2018). Biological control of plant pathogens by *Bacillus* species. *J. Biotechnol.* 285:44-55.
2. Köhl, J., Kolnaar, R. and W. J. Ravensberg (2019). Mode of action of microbial biological control agents against plant diseases: relevance beyond efficacy. *Fro. Plant Sci.* 845. 1-19
3. Lahlali, R., Ezrari, S., Radouane, N., Kenfaoui, J., Esmaeel, Q., El Hamss, H., Belabess, Z. and Barka, E.A. (2022). Biological control of plant pathogens: A global perspective. *Microorganisms*, 10(3):596- 629.
4. Poveda, J. and Eugui, D. (2022). Combined use of *Trichoderma* and beneficial bacteria (mainly *Bacillus* and *Pseudomonas*): Development of microbial synergistic bio-inoculants in sustainable agriculture. *Biol. Control*, 1-19.
5. Sehrawat, A. and Sindhu, S.S. (2019). Potential of biocontrol agents in plant disease control for improving food safety. *Def. Life Sci. J.*, 4(4):220-225.
6. Sharma, K. (2018). Mushroom: Cultivation and processing. *Int. J. of Food Processing Technology*, 5(2):9-12.

23AG2122 EXPERIENTIAL LEARNING PROGRAM-COMMERCIAL SERICULTURE

Credits (0+ 10)

Course Objectives

To impart knowledge on:

1. Principles and techniques of Mulberry and Non-Mulberry Silkworm Rearing.
2. Increased cocoon productivity and prevention of silkworm diseases.
3. Entrepreneurial skills and practices in Sericulture.

Course Outcomes

On completion of this course, students will be able to:

1. Identify different silkworm races available in India.
2. Gain capabilities in culturing methods of Mulberry, Eri and Tussar silkworms.

3. Develop skills in establishing silkworm rearing house, handling of rearing appliances, application of disinfectants and harvesting cocoons.
4. Identify and manage the pests and diseases of mulberry silkworm and mulberry crop.
5. Acquire hands-on training and confidence to establish scientific grainage to produce healthy Disease Free Layings (DFLs).
6. To develop entrepreneurial skills in commercial silkworm rearing and marketing.

Grainage: Morphology of silkworm egg, chawki. Seed cocoon processing/handling – deflossing, sorting and preservation – pupal examination and sex separation of pupa and moth. Treatment of eggs with acid, acid preparation. Visit to seed cocoon markets, commercial grainage and cold storage centre to know the activities of cocoon markets, preparation of laying and cold storage of eggs. Post cocoon technology: Cocoon stifling (sun drying, steam stifling, hot air stifling), storage of cocoon, sorting of cocoons. Deflossing, cocoon riddling, mixing or blending, cocoon cooking, brushing. Concept of difference reeling machines, reeling operation, reeling end formation. Degumming, bleaching, dyeing of silk yarn. Twisting, Reeling, Re-reeling, lacing, skeining and testing of raw silk material -Weaving of silk. General classification of textile fibres. Difference between nature and synthetic fibres according to their composition and properties. Identification of Silk Textile Fibres by Physical and Chemical Test: Microscopic Examination, Flame Test, Solubility Test; Longitudinal and cross section view of silk textile fibres and their impact on physio-mechanical properties like tenacity, elongation toughness, elastic recovery and moisture absorption. Introduction and Objective of Degumming Methods. Silk Bleaching, Silk Dyeing – Acid and Basic Dyeing Processing. Introduction of Different Classes of Dyes and Chemicals used for Silk Dyeing. Economics: Principles of economics, micro and macroeconomics; Unit 2: Advantages and characteristics of sericulture. Scope of sericulture in India – Vis-à- Vis other agricultural crops - income and employment generation. Economics of silkworm egg production in government and private grainage. Economics of mulberry production under rain-fed and irrigated systems; comparative economics of mulberry production under traditional and improved practices. Economics of raw silk production in charka, cottage basin and multi-end reeling units.

Textbooks

1. David, B. V. and V. V. Ramamurthy. (2017). *Elements of Economic Entomology: 8th Edition*. Brillion Publishing, New Delhi.
2. Ragumoorthi, K.N., M. R. Srinivasan, and V. Balasubramani. (2022). *Principles of Applied Entomology: 3rd Edition*. Asha Books House, India.

References:

1. Ganga, G., and J. Sulochana Chetty. (1991) an introduction to sericulture. Oxford & IBH publishing
2. Kumaresan, P. and G. Srinivasa (2005) sericulture extension management and economics. Central silk board, Bangalore.
3. Morohoshi, S. (2001). Development physiology of silkworms. Science publishers, U.S
4. Narasimhana M.L. (1988). Manual on silkworm egg production, Central Silk Board, Bangalore, India.
5. Sonwalker, T.N. (1993). Handbook of Silk Technology, New Age International Pvt., Ltd.

23AG2123 EXPERIENTIAL LEARNING PROGRAM-CROP PRODUCTION AND PROCESSING OF TURMERIC

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Cultivation practices in turmeric production from seed to harvest.
2. Post-harvest processing of turmeric- curing, solvent extraction procedures.
3. To develop value-added products of turmeric.

Course Outcomes

On completion of this course, students will be able to:

1. Cultivate and produce turmeric beginning from seed to harvest.
2. Adopt all package of practices recommendation in turmeric crop production.
3. Undertake pest, disease and weed management using integrated techniques.
4. Learn the various post-harvest processing methods of turmeric.
5. Extract essential oil and oleoresin from turmeric rhizomes.
6. Develop marketing strategies for turmeric and value-added products.

Soil analysis - physical, chemical and biological properties. Reclamation if any needed. Mobilization of organic manures and inorganic manures – procurement of seed rhizome – preparation for sowing. Field preparation – ridges and furrows – basal application of manures – sowing – optimum size of rhizomes – life irrigation and further irrigations – hand weeding – earthing up – top dressing – plant protection measures. Harvest through digging fork or tractor and separation of finger and mother rhizome and sorting – storage of rhizomes – primary processing and secondary processing – curing – boiling – drying – polishing – packaging, monitoring of storage pest and diseases. Extraction of essential oil – oleoresin – curcumin – quality parameters for oil and turmeric powder. Development, preparation and sales of value-added products of turmeric. Marketing of turmeric based on price forecast, working out cost-benefit analysis, report writing, visit to turmeric-growing/processing areas.

Textbooks

1. Karthic, V., Amaranath, J. S. and T. Alagumani (2011). *Production, Processing and Marketing of Turmeric*. Lambert Academic Publishing.
2. Prabhakaran Nair, K. P. (2013). *The Agronomy and Economy of Turmeric and Ginger*. Elsevier.

References

1. Chadha, K. L. (2001). *Hand Book of Horticulture*. Directorate of Information and Publications of Agriculture, ICAR, New Delhi.
2. Farooqui, A. A. and B.S. Sreeramu (2001). Cultivation of medicinal and aromatic plants. *United Press Limited*.
3. Indurani, C., Dharini, M., Ganapathy, S. and B. Chandra Singh (2019). Effect of processing of turmeric rhizomes (*Curcuma longa* L.) on the concentrations of bioactive constituents. *The Canadian Society for Bioengineering*: 1-5.
4. Prasath, D., Krishnamurthy, K. S., Praveena, R., Jayashree, E., Leela, N. K., Sellaperumal, C. and S. Aarthi (2022). *Turmeric*. ICAR - Indian Institute of Spices Research, Kozhikode, Kerala.
5. Reshma, H., Naik, M. and Y.C.Vishwanath (2020). Advances in production technology of turmeric. *Journal of Pharmacognosy and Phytochemistry*., 9(4): 1198-1203.
6. Srinivas. P., Nirmala, G. and S. Bhavani (2019). Processing of turmeric. *In-Management and processing of Horticultural crops*: pp: 34-39.

23AG2124 EXPERIENTIAL LEARNING PROGRAM-CROP PRODUCTION AND STORAGE OF SMALL ONION

Credits (0+ 10)

Course Objectives

To impart knowledge on:

1. Crop production practices of small onion.
2. Cost-efficient storage methods, and post-harvest pest and disease management during storage.
3. Market intelligence and support system for sale of small onion.

Course Outcomes

On completion of this course, students will be able to:

1. Identify and select quality planting material and improved varieties of small onion.
2. Adopt recommended and improved practices in producing quality onion bulbs.
3. Manage pest, diseases and weed in small onion cultivation.
4. Practice efficient harvesting and get familiarized with various storage methods and structures of small onion.
5. Adopt appropriate post-harvest handling procedures to overcome sprouting in storage.
6. Develop marketing strategies to maximize profit in small onion cultivation.

Soil analysis – physical, chemical and biological properties, soil nutrient status. Seed material – selection, cleaning and grading. Field preparation – ploughing, levelling, preparation of beds, application of basal dose, sowing, spacing requirement, irrigation Intercultural operations – weeding, irrigation, gap filling, top dressing, earthing up, and plant protection activities. Assessment of crop maturity and harvesting. Cleaning, grading, sorting, storage and post- harvest management. Monitoring of storage pests and diseases, marketing based on price forecast, working out cost-benefit analysis, report writing, visit to local onion-growing areas.

Textbooks

1. Lucky, J. (2017). *Onion farming: A step to guide on how to grow Onions*, Independently Published.

2. NPCS Board of Consultants & Engineers, (2015). The complete book on Onion & Garlic cultivation with processing. Asia Pacific Business Press Inc.

References

1. Bharathi, C. S. and Mohan, B. (2018). Community small onion / multiplier onion (*Allium cepa* var. aggregatum) nursery as a contingency measure for delayed planting in nicra village of Namakkal District, Tamil Nadu, India. *Int. J. Curr. Microbiol. App. Sci.*, 7(3): 1974-1984.
2. Desh Raj, C., (2018). Scientific Cultivation of Onion (*Allium cepa* L.). Brillion Publishing, New Delhi.
3. Gavino, A. R., Gavino, H. And Cinense, M., (2020). *Development of a pull-type onion (Allium cepa L.) sowing machine for seedbed*. E3S Web of Conferences, 187.
4. Mishra, R. K., Jaiswal, R. K., Kumar, D., Saabale, P. and Singh, A., (2014). Management of major diseases and insect pests of onion and garlic: A comprehensive review. *Journal of Plant Breeding and Crop Science*, 6(11): 160-170.
5. Pugalendhi, L. and Thangamani, C., (2011). Evaluation of aggregatum onion (*Allium cepa* L. var. aggregatum) genotypes. *Allium and Umbelliferae Improvement Newsletter*. 21: 1-5.
6. Sangam, V. and Aski, S. G., (2018). Constraints faced by onion growers in adopting improved practices and suggestions from onion growers to overcome constraints. *Agriculture Update*, 13(3): 355–358.

23AG2125 EXPERIENTIAL LEARNING PROGRAM-QUAIL PRODUCTION TECHNOLOGY

Credits (0+10)

Course Objectives

To impart knowledge on:

1. Benefits and purpose of quail farming.
2. Identifying the different breeds of quails.
3. Management tips of quail farms.

Course Outcomes

On completion of this course, students will be able to:

1. Demonstrate the significance of quail farming.
2. Design the housing of quails.
3. Carry out the brooding of chicks and ensure optimal environmental conditions such as temperature, light intensity, moisture level, ventilation etc.
4. Practise scientific feeding program based on the growth stages of chicks.
5. Maintain clean and healthy environment in and around the farm.
6. Identify the common diseases and carry out prophylactic and preventive measures to be adopted in a quail farm.

Introduction-Quails vis-a-vis Chickens, Reasons for Quail farming. Breeds of Quails-Egg type and Feather type, Composition and nutritional content of quail eggs and Quail meat. Rearing of Quails- Incubation- Floor and cage rearing- Rearing – Brooding chicks, Growers and Layers, Preparation of feed for Quails, Disease management and Health care. Collection and marketing of Quail eggs, Culling and dressing of Quails for meat.

Textbooks

1. Pushkaran, P.S. (2016). *Package of Practices Recommendations for Livestock, Poultry, Elephant, Rabbit, Dog, Pig and Pets*. Kerala Veterinary and Animal Sciences University, Pookod, Kerala.
2. Aruna, T. K. ICAR. (2011). *Handbook of Animal Husbandry*, PUSA, New Delhi.

References

1. Shekhmous, H.H. (2020). Quail Production and Breeding. Lambert Academic Publishing.
2. http://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20quail%20farming.html
3. <http://vikaspedia.in/agriculture/poultry/quail-farming>
4. <http://www.krishisewa.com/articles/livestock/416-quail-farming.html>
5. <http://www.agrifarming.in/quail-farming/>

23AG2057 AGRI-BUSINESS MANAGEMENT

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

1. Basic concepts -marketing tools and techniques of agri-business management.

2. Organisational behaviour of Agri-business models.
3. Principles governing the financial management in Agri-business.

Course Outcomes

On completion of this course, students will be able to:

1. Decipher the micro and macro environmental forces and their impact on agri-business.
2. Improve capabilities in financial and investment decisions.
3. Conceive, initiate and develop new projects leading to new startups / individual business entities.
4. Apply the knowledge of the basic concepts in developing an efficient Marketing Information System.
5. Overcome the issues and challenges existing in rural markets.
6. Acquire the latest marketing practices defined in trade regime's, different WTO laws and international trading in agriculture.

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries. Agri-value chain: Understanding primary and support activities and their linkages. Business environment: PEST & SWOT analysis. Management functions: Roles & activities, Organization culture. Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, policies procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital Management and Financial management of Agribusiness. Financial statements and their importance. Marketing Management: Segmentation, targeting & positioning. Marketing mix and marketing strategies. Consumer behaviour analysis, Product Life Cycle (PLC). Sales & Distribution Management. Pricing policy, various pricing methods. Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation. Project Appraisal and evaluation techniques.

Practical

Study of agri-input markets: Seed, fertilizers, pesticides. Study of output markets: grains, fruits, vegetables, flowers. Study of product markets, retails trade commodity trading, and value added products. Study of financing institutions- Cooperative, Commercial banks, RRBs, Agribusiness Finance Limited, NABARD. Preparations of projects and Feasibility reports for agribusiness entrepreneur. Appraisal/evaluation techniques of identifying viable project- Non-discounting techniques. Case study of agro-based industries. Trend and growth rate of prices of agricultural commodities. Net present worth technique for selection of viable project. Internal rate of return.

Textbooks

1. Acharya, S.S and Agarwal. N L. (2019). *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Raju, V.T. and D.V.S. Rao. (2014). *Economics of Farm Production and Management*. Oxford and IBH Publishers, New Delhi.

References

1. Barnard, F. L., Foltz, J., Yeager, E. A. and B. Brewer. (2020). *Agribusiness management*. Routledge.
2. Krishnamacharyulu, C. and L. Ramakrishan (2002). *Rural Marketing*. Pearson Edu.
3. Michael E.P. (1998). *Competitive Advantage: Creating and Sustaining Superior Performance*, Free Press, New York.
4. Ramaswamy V.S. and S. Nanakumari (2006). *Marketing Management*. 3rd Ed. MacMillan Publ.
5. Richard L., Kohls and Joseph N Uhl. (1998). *Marketing of Agricultural Products*. Prentice Hall. New Jersey.

23AG2205 COMMERCIAL PLANT BREEDING

Credits 3 (1+2)

Course Objectives

To impart knowledge on:

1. Development of lines, hybrids and seed production.
2. Alternative approaches for the development of lines and cultivars.

3. Intellectual Property Rights, DUS Testing and variety registration.

Course Outcomes

On completion of this course, students will be able to:

1. Remember the fundamentals of plant reproduction and their floral biology.
2. Understand the techniques of development and maintenance of breeding lines.
3. Apply the breeding methods to produce marketable hybrid seeds of various crops.
4. Apply the tools and techniques for optimizing quality seed production.
5. Analyze alternative strategies for the development of breeding lines.
6. Evaluate DUS testing and quality seed testing for commercial hybrid seeds.

Theory

Types of crops and modes of plant reproduction. Line development and maintenance breeding in self and cross pollinated crops (A/B/R and two line system) for development of hybrids and seed production. Genetic purity test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line and cultivars: haploid inducer, tissue culture techniques and biotechnological tools. IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act. Variety testing, release and notification systems in India. Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Techniques of seed production in self and cross pollinated crops using A/B/R and two line system. Learning techniques in hybrid seed production using male-sterility in field crops. Understanding the difficulties in hybrid seed production, Tools and techniques for optimizing hybrid seed production. Concept of rouging in seed production plot. Concept of line its multiplication and purification in hybrid seed production. Role of pollinators in hybrid seed production. Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops. Sampling and analytical procedures for purity testing and detection of spurious seed. Seed drying and storage structure in quality seed management. Screening techniques during seed processing viz., grading and packaging. Visit to public private seed production and processing plants.

Textbooks

1. Agarwal.P.K, (2017). *Principles of Seed Technology*. South Asian Publishers, New Delhi.
2. Kochhar. S. L. (2016). *Economic Botany in the Tropics*: Fifth Edition. Cambridge University Press, USA.

References

1. Singh, B. D. (2014). *Plant Breeding - Principles and Methods*. Kalyani Publishers, Ludhiana.
2. Simmonds, N.W. and J. Smart (2014). *Principles of Crop Improvement*. Wiley India Pvt. Ltd., New Delhi.
3. Acquaah, G. (2007). *Principles of Plant Genetics and Breeding*, Blackwell Publishing, Malden.
4. Singh, S. and Pawar, I. S. (2006). *Genetic Bases and Methods of Plant Breeding*. CBS Publishers, New Delhi.
5. Sleper, D.A. & Poehlman, J.M. (2006). *Breeding Field Crops*, Blackwell, Iowa.

23AG2275 FOOD SAFETY AND STANDARDS

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

1. Food safety, risks and hazards.
2. Food hygiene, sanitation and food safety management tools- PRPs, GHPs, GMPs, SSOPs, HACCP.
3. Laws, quality standards, packaging, and labelling of food products.

Course Outcomes

On completion of this course, students will be able to:

1. Learn the various practices and protocols of hygiene and sanitation in food service establishments.
2. Acquire knowledge on factors affecting food safety, risks and types of hazards.
3. Acquire hands-on experience and skills in overcoming food safety hazards.
4. Familiarize with food safety management tools.
5. Update on newer technologies and standards of food safety.
6. Adopt the relevant food laws, standards and apply the regulatory regimes.

Theory

Food Safety – Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Types of hazards - Biological, Chemical, Physical hazards. Management of hazards - Need. Control of parameters. Temperature control. Food storage. Product design. Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control. Waste Disposal. Pest and Rodent Control. Personnel Hygiene. Food Safety Measures. Food Safety Management Tools- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP. ISO series. TQM-concept and need for quality, components of TQM, Kaizen. Risk Analysis. Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygiene. Food laws and Standards- Indian Food Regulatory Regime, FSSAI. Global Scenario CAC. Other laws and standards related to food. Recent concerns- New and Emerging Pathogens. Packaging, Product labeling and Nutritional labeling. Genetically modified foods\ transgenics. Organic foods. Newer approaches to food safety. Recent Outbreaks. Indian and International Standards for food products.

Practical

Water quality analysis physico-chemical and microbiological. Preparation of different types of media. Microbiological Examination of different food samples. Assessment of surface sanitation by swab/rinse method. Assessment of personal hygiene. Biochemical tests for identification of bacteria. Scheme for the detection of food borne pathogens. Preparation of plans for Implementation of FSMS - HACCP, ISO: 22000.

Textbooks

1. Doyle, M. P., Diez-Gonzalez, F. and C. Hill. (2020). *Food Microbiology: Fundamentals and Frontiers*. John Wiley & Sons. 1100p.
2. Taormina, P. J. and M.D. Hardin. (2021). *Food Safety and Quality-Based Shelf Life of Perishable Foods*. Springer Nature. 161p.

References:

1. Bonne, R., Wright, N., Camberou, L., & Boccas, F. (2005). Guidelines on HACCP, GMP, and GHP for Asean food SMEs. *EC-ASEAN Economic Cooperation Programme on Standards, Quality & Conformity Assessment*. 98p.
2. Food and Agriculture Organization of the United Nations. (2003). *Food Quality and Safety Systems: A Training Manual on Food Hygiene and the Hazard Analysis and Critical Control Point (HACCP) System*. 244p.
3. Lasztity, R., Petro-Turza, M., and Foldesi, T. (2009). History of food quality standards. *Food quality and standards*, 1, 62-77.
4. Lawley, R., Curtis, L. and J. Davis (2008). *The Food Safety Hazard Guidebook*. Royal Society of Chemistry. 422p.
5. Mortimore, S. E. and C. A. Wallace. (2015). *HACCP: A Food Industry Briefing*. John Wiley & Sons. 192p.
6. Savov, A. V., and Kouzmanov, G. B. (2009). Food quality and safety standards at a glance. *Biotechnology & Biotechnological Equipment*, 23(4), 1462-1468.

23AG2309 BIOPESTICIDES & BIOFERTILIZERS

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

1. Significance and scope of biopesticides and biofertilizers in sustainable farming.
2. Production technologies of various bio-inoculants for soil and plant health.
3. Quality control, Statutory Regulations and Marketing of biopesticides and biofertilizers.

Course Outcomes

On completion of this course, students will be able to:

1. Differentiate bacteria, fungi and algae based bio-inoculants (biopesticides and biofertilizers).
2. Apply the concepts and mechanisms of plant growth promoting traits of bio-inoculants.
3. Make use of the established plant based pesticidal formulations in integrated farming.
4. Acquire hands on experience in production of various bio-inoculants and their targeted delivery.
5. Ensure registration and adoption of all the statutory quality control guidelines of regulatory bodies.

- Analyse the market strategies and impediments in promoting bio-inoculants.

Theory

History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides viz. pathogen, botanical pesticides, and biorationals. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes. Methods of application of biopesticides. Methods of quality control and Techniques of biopesticides. Impediments and limitation in production and use of biopesticide.

Biofertilizers - Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*; Cyanobacterial biofertilizers- *Anabaena*, *Nostoc*, *Hapalosiphon* and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

Practical

Isolation and purification of important biopesticides: *Trichoderma*, *Pseudomonas*, *Bacillus*, *Metarhizium* etc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides.

Isolation and purification of *Azospirillum*, *Azotobacter*, *Rhizobium*, P-solubilizers and cyanobacteria. Mass multiplication and inoculum production of biofertilizers. Isolation of AM fungi -Wet sieving method and sucrose gradient method. Mass production of AM inoculants.

Textbooks

- Kannaiyan S., Kumar K. and K. Govindarajan. (2013). *Biofertilizer Technology*. 1st Edn. Scientific Publishers, India
- Rai, M.K. (2006). *Handbook of biofertilizers*. The Haworth Press, Inc., US.

References

- Acharya, K., S. Sen and R. Manjula Rai. (2019). *Biofertilizers and Biopesticides*. Publisher: Techno World, Kolkata, India.
- Dubey, R.C. and Maheswari. (2010). *A Text Book of Microbiology*. S. Chand Pvt Ltd., India
- Jamaluddin and A.K. Singh. (2014). *Microbes and Sustainable Plant Productivity*. Scientific Publishers, India.
- Micahel T.M. (2017). *Brock Biology of Microorganisms*. 14th Edn. Pearson Publishers. India
- Vladimir, V. G., Jose, A.P.M. and Y.G. Svetlana. (2020). *Microbial Pesticides: Biological Resources, Production and Application*. Elsevier Science, The Netherlands.

23AG2454 PROTECTED CULTIVATION

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

- Basics of protected cultivation.
- Requirements of cultivation in protected situations.
- Different techniques involved in protected cultivation.

Course Outcomes

On completion of this course, students will be able to:

- Plan and design of low-cost greenhouses.
- Use foggers to create humidity in air at different environmental conditions.
- Monitor plant growth in Greenhouse using wireless sensors.
- Regulation and maintenance of devices through IoT.
- Design computer-based control and remote operation of drip irrigation and fertigation in greenhouse.
- Hands on experience in understanding greenhouse effect and off-season production of crops.

Theory

Protected cultivation- importance and scope, Status of protected cultivation in India and World types of protected structure based on site and climate. Cladding material involved in greenhouse/ poly house.

Greenhouse design, environment control, artificial lights, Automation. Soil preparation and management, Substrate management. Types of benches and containers. Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops – rose, carnation, chrysanthemum, gerbera, orchid, anthurium, liliun, tulip, tomato, bell pepper, cucumber, strawberry, pot plants, etc. Cultivation of economically important medicinal and aromatic plants. Off-season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, use of portrays in quality Planting material production, Bed preparation and planting of crop for production, Inter cultural operations, Soil EC and pH measurement, Regulation of irrigation and fertilizers through drip, fogging ad misting.

Textbooks

1. Dinkar J. G. and T.S.S. Maitra. (2021). *A textbook of Protected Cultivation and Smart Agriculture*. M/s New Delhi Publishers, 90, Sainik Vihar, Mohan Garden, Uttam Nagar, New Delhi-1100591.
2. Ashok Kumar,B., Ramesh, E. and V. Sindhu. (2020). *A textbook of Protected Cultivation and Precision Farming for Horticultural Crops*. M/s Jain Brothers 16/873, East Park Road, Karol Bagh, New Delhi-110 005.
3. Singh, D. K and K.V. Peter. (2014). *Protected Cultivation of Horticultural Crops*. M/s New India Publishing Agency, Pitam Pura, New Delhi-110088.

References

1. Sanjeev K., Saravaiya, S.N. and A. K. Pandey. (2021). *Precision farming & protected cultivation: Concepts and Applications*. M/s Indian Books and Periodicals, Pahar ganj, New Delhi, 1100551.
2. Radha Manohar, K. and C. Ignathinathane. (2015). *Greenhouse Technology and Management*. 2nd edition. B. S. Publications.
3. Singh,B., Singh,B., Sabir, N. and M. Hasan. (2014). *Advances in Protected Cultivation*. New India Publishing Agency, New Delhi.
4. Hunt, D. (2013). *Farm Power and Machinery Management*. 10th edition. MedTec Publishers, New Delhi.
5. Jana, B. L. (2008). *Precision Farming*. AgroTech Publishing Academy.
6. Sahu, K.C. (2008). *Textbook of Remote Sensing and Geographical Information Systems*. Atlantic Publishers and Distributors Pvt Ltd.

23AG2276 MICRO PROPAGATION TECHNOLOGIES

Credits 3 (1+2)

Course Objectives

To impart knowledge on:

1. The basic principles and applications of micropropagation techniques.
2. Laboratory hygiene and protocols, media preparation, sterilization methods and growth conditions
3. The various micro propagation methods – meristem culture, direct and indirect organogenesis and embryogenesis, soma clonal variation, haploid culture, embryo culture and protoplast culture and hardening procedures for tissue culture plantlets.

Course Outcomes

On completion of this course, students will be able to:

1. Understand the concepts and principles of plant tissue culture
2. Learn the various methods of explant sterilization and inoculation procedures
3. Prepare different media used in tissue culture and its application for different crops
4. Gain experience on various micropropagation methods such as meristem culture, enhanced release of axillary buds, direct and indirect organogenesis, embryogenesis, anther and embryo culture
5. Identify the soma clonal variants and problems arising due to soma clonal variations
6. Familiarize with the conditions and structures used in hardening of plantlets

Theory

Introduction, History, advantages and limitations; Types of cultures (seed, embryo, organ, callus, cell), Stages of micropropagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture), Organogenesis (callus and direct organ formation), Somatic embryogenesis, cell suspension cultures, Production of secondary metabolites, somaclonal variation, Cryopreservation

Practical

Identification and use of equipment in tissue culture Laboratory, Nutrition media composition, sterilization techniques for

media, containers and small instruments, sterilization techniques for explants, Preparation of stocks and working solution, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, Induction of somatic embryos regeneration of whole plants from different explants, Hardening procedures.

Textbooks

1. Razdan, M.K. (2019). *Introduction to Plant Tissue Culture*. 3rd Ed. Paperback. Oxford & IBH Publishing Co, New Delhi.
2. Singh, D.K. (2017). *Micropropagation Technologies*. ATPA, Udaipur.

References

1. Adheena, E. J. (2019). *Lessons for Plant Micropropagation*. Educreation Publishing, New Delhi.
2. Jha, T.B. and Ghosh, B. (2016). *Plant Tissue Culture: Basic and Applied*. Platinum Publishers, Kolkata.
3. Kalyan Kumar De. (2020). *Plant Tissue Culture*. NCBA, Kenya.
4. Long, Y., Yang, Y., Pan, G, and Shen, Y. (2022). *New Insights into Tissue Culture Plant Regeneration Mechanisms*. Frontiers in Plant Science.
5. Plant Tissue Culture, A Review. (2017). SGVU Journal of Pharmaceutical Research and Education.
6. Pullaiah, T., Subba Rao, M.V., Sreedevi E. (2022). *Plant Tissue Culture: Theory and Practicals*. Scientific Publishers, New Delhi.
7. Smith, R.H. (2013). *Plant Tissue Culture Techniques and Experiments*. 3rd edition. Elsevier, Netherlands.
8. Turcotte, H. (2020). *Micropropagation of Horticultural Crops*. White Press Academic, New Orleans, US.

23AG2277 HI-TECH HORTICULTURE

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

1. Precision farming of Horticultural crops
2. Protected cultivation, design of greenhouse structures, use of sensors and irrigation control systems
3. High density orcharding, canopy management, fertigation and micro irrigation systems

Course Outcomes

On completion of this course, students will be able to:

1. Gain knowledge on modern field preparation and planting methods including high density, micro irrigation and fertigation.
2. Gain experience in canopy management in high density orcharding.
3. Learn about the components of precision farming including remote sensing, GIS, GPS, and VRA.
4. Design different protected structures, micro irrigation systems and adopt different fertilizer schedules.
5. Perform intercultural operations using modern machinery.
6. Learn about micropropagation techniques in relation to precision farming.

Theory

Introduction & importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods, Protected cultivation: advantages, controlled conditions, method and techniques, Micro irrigation systems and its components; EC, pH based fertilizer scheduling, canopy management, high density orcharding, Components of precision farming: Remote sensing, Geographical Information System (GIS), Differential Geo-positioning System (DGPS), Variable Rate applicator (VRA), application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practical

Types of polyhouses and shade net houses, Intercultural operations, tools and equipments identification and application, Micro propagation, Nursery-protrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

Textbooks

1. Rajendra, S. R., Praveen, K. S., Rajiv, K. N. and Raksha, P. S. (2021). *Hi-Tech Horticulture: Approaches for Cultivation and Value Addition*. Om publications.
2. Sachin, T. (2019). *Hi-Tech Horticulture: Volume 6: Advance Techniques*. New India Publishing Agency- Nipa, New Delhi.

References

1. Brahma, S., Balraj, S., Naved, S. and M. Hasan. (2014). *Advances in Protected Cultivation*. New India Publishing Agency, New Delhi.
2. David, R., (1996). *Water, media and nutrition for green house crops*. Ball publishing, USA.
3. Jana, B. L., (2008). *Precision Farming*. AgroTech Publishing Academy.
4. Kali, C. S., (2008). *Text Book of Remote Sensing and Geographical Information Systems*. Atlantic Publishers and Distributors Pvt Ltd.
5. Radhamanohar, K. and C. Ignathinathane (2015). *Greenhouse Technology and Management*. 2nd edition. B. S. Publications.
6. Sachin, T. (2019). *Hi-Tech Horticulture: Volume 1: Crop Improvement, Nursery and Rootstock Management*. New India Publishing Agency- Nipa, New Delhi.

23AG2012 SYSTEM SIMULATION AND AGRO ADVISORY

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

1. Crop models, concepts and techniques in agriculture
2. Weather forecasting, methods, tools and techniques in agriculture
3. Preparation of agro-advisories and its effective dissemination.

Course Outcomes

At the end of this course, the students will be able to:

1. Define the critical phases in the pheno-phasic development of important field crops.
2. Assess and differentiate various crop simulation models.
3. Apply crop simulation models and their concepts on growth and yield of field crops.
4. Infer crop responses to weather elements, develop crop weather calendars and skills in crop weather forecasting.
5. Develop and disseminate effective agro advisories for different cropping systems.
6. Use of different channels for disseminating agro-advisories to farmers.

Theory

System Approach for representing soil-plant-atmospheric continuum, system boundaries, Crop models, concepts & techniques, types of crop models, data requirements, relational diagrams. Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis. Potential and achievable crop production- concept and modelling techniques for their estimation. Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance. Weather forecasting, types, methods, tools & techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop-Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast. Use of crop simulation model for preparation of Agro-advisory and its effective dissemination.

Practical

Preparation of crop weather calendars. Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts. Working with statistical and simulation models for crop growth. Potential & achievable production; yield forecasting, insect & disease forecasting models. Simulation with limitations of water and nutrient management options. Sensitivity analysis of varying weather and crop management practices. Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast. Feedback from farmers about the agro-advisory.

Textbooks

1. Mavi, H.S., (2019). *Introduction to Agrometeorology*. Second Edition. Oxford & IBH Publishing Co Pvt.Ltd, New Delhi, India.
2. Radha Krishna Murthy, V., Sree Rekha, M., and B Jyothi Basu. (2020). *Practical*
3. *Manual on Agrometeorology*. BS Publ., Hyderabad, India.

References

1. Patra, A.K. (2016). *Principles and applications of Agricultural Meteorology*. New
2. Reddy, S.R. (2016). *Introduction to Agriculture and Agrometeorology*. Kalyani
3. Bishnoi, O.P. (2010). *Applied Agroclimatology*, Oxford Book Company, Jaipur,
4. Prasada Rao, G.S.L.H.V. (2008). *Agricultural meteorology*. PHI Learning Private
5. Wallach, D., Makowshi, D and Jones, J. W. (2006). *Working with Dynamic crop*

6. Mavi, H.S. and Tupper, G.J. (2004). Agrometeorology: Principles and Application

Web References

1. www.tropmet.res.in/
2. www.imd.gov.in
3. www.usbr.gov/pn/agri.met
4. www.tawn.tnau.ac.in

23AG2126 AGRICULTURAL JOURNALISM

Credits 3 (2+1)

Course Objectives

To impart knowledge on:

1. Principles, ethics and practices on agriculture news dissemination.
2. Skill development in newsgathering, writing style and language for agriculture
3. leaflets, pamphlets, newspaper, magazine, and mass media including various online
4. digital platforms.
5. Use of multimedia tools for illustrating agricultural stories and editorial mechanics.

Course Outcomes

On completion of this course, students will be able to:

1. Efficiently gather agricultural news and updates.
2. Develop competency in writing, editing and content development of agri-news.
3. Apply editorial mechanics such as proof reading, copy editing and develop captivating headlines / titles.
4. Individually develop write-ups, news clippings and presentations for news media such as newspapers, magazines and electronic media.
5. Update on the latest journalistic approaches, style and presentations.
6. Develop skills in recent advances in photography, videography, post-processing and editorial decision making.

Theory

Agricultural Journalism: The nature and scope of agricultural journalism characteristics and training of the agricultural journalist, how agricultural journalism is similar to and different from other types of journalism. Newspapers and magazines as communication media: Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers. Form and content of newspapers and magazines: Style and language of newspapers and magazines, parts of newspapers and magazines. The agricultural story: Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story. Gathering agricultural information: Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources. Writing the story: Organizing the material, treatment of the story, writing the news lead and the body, readability measures. Illustrating agricultural stories: Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions. Editorial mechanics: Copy reading, headline and title writing, proofreading, layouting.

Practical

Practice in interviewing. Covering agricultural events. Abstracting stories from research and scientific materials and from wire services. Writing different types of agricultural stories. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading, headline and title writing, proofreading, layouting. Testing copy with a readability formula. Visit to a publishing office.

Textbooks

1. Jana, B.L. (2014). *Agricultural Journalism*. Agrotech publishing Academy, Udaipur.
2. Singh, A.K. (2019). *Agricultural Extension and Farm Journalism*. Bio Green Books, Agrobios publication, New Delhi.
3. Sagar, M. and S.K. Das (2018). *Agricultural Extension and Rural Journalism*. Kalyani Publishers, New Delhi.

References

1. Bisarya, S.S., Ojha, R. and R. S. Bisarya. (2016). *Agriculture Journalism*. Notion press.
2. Rana and Priyanka (2000). *Textbook of Agricultural Journalism*. SIBT publication,
3. Jodhpur.
4. Sandhu, A.S. (2021) *Textbook on Agricultural Communication-Practices and*

5. *Methods*. CBS Publishers and Distributors pvt Ltd, New Delhi.
6. Struck, W. and E. White. (2000). *The Elements of Style*. Macmillan Publishing Co., Inc., UK.
7. Van Den Ban, A.W and Hawkins H.S (2000). *Agricultural Extension*. CBS Publishers and Distributors pvt Ltd, New Delhi.

PhD (Part time) Syllabus for Soil Science and Agri Business Management
Part-Time Ph.D. (External) in Soil Science
COURSE STRUCTURE AT A GLANCE

CODE	COURSE TITLE	CREDITS
23AG3264	Soil Genesis and Micropedology	3(3+0)
23AG3265	Soil Resource Inventory and Management	3(3+0)
23AG3266	Advances in Plant nutrition and Crop quality	3(3+0)
23AG3267	Advances in Soil Physics	2(2+0)
23AG3268	Advances in Soil Fertility	2(2+0)
23AG3269	Physical Chemistry of Soils	2(2+0)

23AG3264 SOIL GENESIS AND MICROPEDOLOGY

Credits: 3:0:0

Course Objectives

To impart knowledge on:

1. Pedogenic processes in soils and the micro-pedological study of soil profile.
2. Soil genesis as a prerequisite for sound land use planning and land management.
3. Principles of microscopic pedology and its application in the different branches of soil science.

Course Outcomes

On completion of this course, students will be able to:

1. Describe the pedogenic evolution and concept of soil genesis.
2. Classify the soil forming rocks and minerals and explain the soil forming factors and processes.
3. Assess the soil profile development by morphological and mineralogical analysis.
4. Explain the importance of micro pedology in soil formation, soil mapping and soil classification.
5. Characterize the physico- chemical properties of soil.
6. Identify and describe the established benchmark soil profiles.

Pedogenic evolution and Concept of soil genesis, Soil Minerals - Pedogenic evolution of Soil - Fundamental Concept of soil genesis - Soils – Concepts and definitions - Soil composition – Rock forming minerals, Formation, characterization and classification. Identification and description of major diagnostic and pedological horizons and features. Rocks, Weathering and Soil Formation Rocks – Formation, nature and classification - Weathering of rocks and minerals and soil formation – Soil forming factors and processes in pedogenesis; Stability and weathering sequences of minerals. Soil profile and Its Assessment-Identification Criteria & Application and Soil Orders Soil Profile – Master and transition Horizons – Subordinate designations - Soil Orders - Utility of soil analysis in pedological investigation of soil - Assessment of soil profile development by morphological, mineralogical and chemical analysis. Concepts and Evolution of Micropedology- Its Importance in Soil Formation – Concepts of structure and fabric in Micropedology. Micro-pedological features of soils – Their structure, fabric analysis - Role in genesis and classification. Correlation and classification of Indian and Tamil Nadu soils with reference to Soil Taxonomy. - Identification and description of benchmark soil profiles.

References

1. Sehgal, J. (2014). *A TextBook of Pedology – Concepts and Applications*. Kalyani Publishers, New Delhi.
2. Mary C. B. Fanning, Delvin S. Fanning. (2013). *Soil: Morphology, Genesis And Classification*. 1st Edition. Publisher: Wiley.
3. Buol, S.W., R. J. Southard, R. C. Graham and P. A. Mcdaniel .(2011). *Soil Genesis and Classification*. Sixth Edition. A John Wiley & Sons, Ltd., Publication.
4. Stoops, G. (2009). *Seventy Years’ “Micropedology” 1938-2008: The Past and Future*. J. Mt. Sci. 6: 101–106 DOI: 10.1007/s11629-009-1025-3.

5. Douglas, L.A. (1990). *Soil Micromorphology - A Basic and Applied Science*. Volume 19.1st Edition, Elsevier Science, eBook ISBN: 9780080869872

23AG3265 SOIL RESOURCE INVENTORY AND MANAGEMENT

Credits: 3:0:0

Course Objectives

To impart knowledge on:

1. Soil Resource Inventory and preparation of soil and land use maps.
2. Land use planning and Land evaluation.
3. Land management and sustainable utilization for agricultural purposes.

Course Outcomes

On completion of this course, students will be able to:

1. Explain the principles and concepts of Soil Resource Inventory.
2. Prepare soil and land use maps.
3. Describe the methodology and techniques for land use planning in tropics.
4. Correlate soil survey and agricultural land use data to evaluate the land use planning.
5. Recommend amelioration measures for effective waste land management.
6. Apply the soil physico-chemical properties data in preparation of Watershed Development Projects.

Soil Resource Inventory - principles, concepts and importance - preparation of soil and land use maps. Soil correlation - relationship between soil survey and agricultural land use data - concepts and correlation at various levels. Bench mark soils. Concepts on soil based agro technology transfer. Land use planning – factors governing present land use - principles and techniques - land utilization types - agricultural and non-agricultural utilization types - methodology and techniques for land use planning in tropics. Land evaluation –Qualitative - Change detection in land use - land use planning problems for agricultural and horticultural purposes. Alternative land use- land use policy. Land evaluation - different methods of land evaluation - FAO system - Land capability classification – concepts and different systems – limitations; Land irrigability classification - basis of classification systems developed for semi arid and humid areas. Land evaluation – Quantitative - Crop suitability classification - concepts - interpretation of soils for suitability to grassland and forest trees. Fertility capability classification - relation with soil classification - productivity rating of soils - Storie index - Requier methods. Land Management - Degraded land- extent - management - Soil erosion - universal soil loss equation- silt yield index Watershed development – Concepts and objectives – Wastelands and their extent - delineation and their categorization through GIS- management and utilization of wastelands.

References

1. Dent, D. and Young, A. (1981). *Soil Survey and Land Evaluation*. George Allen and Unwin, London.
2. Soil Survey Staff., (1998). *Keys to Soil Taxonomy*. 8th Ed. USDA & NRCS, Washington, DC.
3. Smyth A. J. and J. Dumasky. (1993). *FELSM: An international framework for evaluating sustainable land management*. Food and Agriculture Organization of the United Nations, Rome (Italy).
4. Sehgal J.L., Mandal D.K., Mandal C. and S. Vadivelu. (1990). *Agro-Ecological Regions of India*. NBSS & LUP, Nagpur.
5. Thomas L., Ralph W. K. (2015). *Remote sensing and image interpretation*, 7th Edition. Wiley Publishers.

23AG3266 ADVANCES IN PLANT NUTRITION AND CROP QUALITY

Credits: 3:0:0

Course Objectives

To impart knowledge on:

1. Nutrient movement and nutrient transformation in soil.
2. Plant sampling techniques and nutrient deficiency/excess symptoms and analysis.
3. Concepts of nutritional requirement, availability, nutrient interactions and physiological functions in crops.

Course Outcomes

On completion of this course, students will be able to:

1. Describe the nutrient availability and mobility in soil and plants.

2. Explain the nutrient transformation in soil.
3. Demonstrate the plant nutrient constraints affecting plant growth, yield and quality.
4. Recommend management strategies to overcome nutrient deficiencies, improve nutrient uptake and nutrient use efficiency.
5. Explain the concepts of critical levels of nutrients availability and balanced nutrient management.
6. Correlate nutrient requirement and availability with respect to crop yield and quality.

Nutrient movement in soil and absorption by plants - Movement of ions from soil to plant roots - mass flow, diffusion - factors - cation exchange capacity of plant roots - Mechanism of ions absorption and uptake by plant roots- factors affecting nutrient absorption. Nutrients transformation in soil - Nutrients transformation in soils under aerobic and anaerobic conditions - macro, secondary and micronutrients. Plant nutrient constraints and plant sampling techniques - Plant nutrient constraints affecting plant growth and quality; plant nutrient deficiencies, toxicities and their diagnosis – Strategies to correct nutrient constraints - Plant sampling techniques and their influence on nutrient uptake assessment and input management. Concepts of nutrient application and nutrient interactions - DRIS - Relationship of Q/I in plant nutrient uptake - foliar fertilization - Chelation and plant nutrient availability - Nutrient interactions - nutrient balance - antagonisms - zero interactions - synergism. Nutrient requirement of crops, nutrient uptake, crop quality – factors and improvement Plant nutrient requirement of different crops, nutrient uptake, nutrient use efficiency and harvest index -Influence of crop variety, plant population, types and time of application of fertilisers on nutrient utilization. Organic matter in relation to nutrient availability, uptake by plants and crop quality. Quality improvement in crops.

References

1. Barker, A.V and Pilbeam, D .J. (2007). *Handbook of Plant Nutrition*. CRC press, Florida.
2. Epstein, E. and Bloom, A. (2005). *Mineral Nutrition of Plants: Principles and Perspectives*. Second edition. Sinauer Associates.
3. Havlin, John L., Tisdale, Samuel L., Nelson, Werner L., and Beaton James D. (2016). *Soil Fertility and Fertilizers: An Introduction to Nutrient Management*. 8th Edition, Pearson Education Inc., USA
4. Marschner, H. (2012). *Mineral Nutrition of Higher Plants*. Academic Press, San Diego.
5. Tandon, H.L.S. (Ed). (1995). *Management of Nutrient Interactions in Agriculture*. FDCO, New Delhi.

22AG3267 ADVANCES IN SOIL PHYSICS

Credits: 2:0:0

Course Objectives

To impart knowledge on:

1. Theories of water flow and soil water interactions.
2. Modern concepts and Models for water movement in soil.
3. Soil physical constraints and their management.

Course Outcomes

On completion of this course, students will be able to:

1. Describe soil-water interactions and soil-water potential concepts.
2. Demonstrate the concepts and theories of soil-water flow.
3. Explain the models for the movement of soil water and soil air.
4. Demonstrate the thermal properties of soil.
5. Identify various soil physical constraints and recommend management practices.
6. Measure the temperature / radiation in the soil and evaluate the soil and plant water status.

Soil Water - Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system. Concepts / Theories of Water Flow - Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional water flow- Theories of horizontal and vertical infiltration under different boundary conditions. Models for water movement / Soil Air - Movement of salts in soils, models for miscible -immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves- Soil air and aeration, mass flow and diffusion processes. Thermal properties of soil / Soil physical constraints and management - Thermal properties of soil, heat transfer in soils, differential equation of heat flow,

measurement of thermal conductivity of soil- Soil crust and clod formation; structural management of puddled rice soils; soil conditioning-concept, soils conditioners - types, characteristics, working principles, significance in agriculture. Temperature / Radiations measurement - Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapo-transpiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

References

1. Hillel D. (1982). *Introduction to Soil Physics*. Academic Press
2. Hanks and Ascheroff. (1980). *Applied Soil Physics*. Springer Verlag.
3. Lal, R. and M.K. Shukla.(2004). *Principles of Soil Physics*. Marcel Dekker.
4. Oswal MC.(1994). *Soil Physics*. Oxford , IBH
5. Teixeira, W.G., Ceddia, M.B., Ottoni, M.V. and G. Kangussu Donnagema., (Eds.). (2014). *Application of Soil Physics in Environmental Analysis*. Springer

23AG3268 ADVANCES IN SOIL FERTILITY

Credits: 2:0:0

Course Objectives

To impart knowledge on:

1. Modern concepts of nutrient availability and nutrient response functions.
2. Concepts of Chemical equilibria and Fertilizer evaluation.
3. Fertilizer application and nutrient management techniques.

Course Outcomes

On completion of this course, students will be able to:

1. Describe the concepts of nutrient availability and nutrient response functions.
2. Explain the models for transformation of essential nutrients in soils.
3. Describe the Concepts of Chemical equilibria and fertilizer evaluation.
4. Elaborate nutrient management approaches.
5. Demonstrate the role of Decision Support Systems in soil fertility management.
6. Explain fertilizer scheduling and it's application techniques in crops.

Concepts of nutrient availability - Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices. Nutrient absorption and transformation. Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of macro and micronutrients in soils. Concepts of Chemical equilibria and fertilizer evaluation - Chemical equilibria (including solid-solution equilibria) involving nutrient ions in soils, particularly in submerged soils. Modern concepts of fertilizer evaluation, -nutrient use efficiency, sensor based nutrient management and nutrient budgeting. Fertilizer application Techniques and Nutrient management - Modern concepts in fertilizer application; Fertigation; soil fertility evaluation techniques – concept and various approaches; role of soil tests and GPS and GIS based soil fertility mapping in fertilizer use; site-specific nutrient management – Nutrient management in Poly house agriculture; Nutrient scheduling for fertigation; Various approaches – STCR-IPNS approach (Inductive cum targeted yield model), Mitscherlich-Bray, Multiple Regression model and SSNM. Concepts of LTFEs and Modern tools in soil fertility - Permanent manurial trials and long-term fertilizer experiments; impact on soil fertility and soil productivity under long-term intensive cropping; Precision farming – concepts and applications – role of Decision support system tools in soil fertility management.

References

1. Vargas Rojas, R., Taboada, M., Saynes Santillán, V., Cardoso Lisboa, C. and C. Olivera, (2022). *Soils for nutrition: state of the art*.
2. Kannaiyan, S., Kumar, K. and K. Govindarajan. (2010). *Biofertilizers Technology*. Scientific Publishers.
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4. Kabata-Pendias, A. and H. Pendias. (2001). *Trace elements in soil and plants*, CRC Press, Boca Raton, London, New-York, Washington, DC.
5. Power, J. F and R. Prasad. (1997). *Soil fertility management for sustainable agriculture*. CRC press.

23AG3269 PHYSICAL CHEMISTRY OF SOILS

Credits: 2:0:0

Course Objectives

To impart knowledge on:

1. Colloidal chemistry and cation exchange equilibria.
2. Thermodynamics of nutrient transformations.
3. Adsorption/ Desorption isotherms and electrochemical properties of clays.

Course Outcomes

On completion of this course, students will be able to:

1. Apply the modern concepts of physical chemistry of soils for improved nutrient use efficiency.
2. Explain the chemistry of soil colloids and clay organic interaction.
3. Elucidate the thermodynamics of nutrient transformations in soils with respect to CEC and AEC
4. Identify and manage nutrient fixation in soils in relation to physico- chemical properties.
5. Work and demonstrate cationic and anionic exchange models.
6. Inferring and applying the utility of adsorption / desorption isotherms in agricultural system.

Colloidal chemistry of inorganic and organic components of soils - their formation, clay organic interaction. Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients; structure and properties of diffuse double layer. Thermodynamics of nutrient transformations in soils; cationic and anionic exchange and their models, molecular interaction.

Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system). Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

References

1. Bolt, G. H. and M.G.M.Bruggenwert. (1978). *Soil chemistry. A. Basic elements*. Elsevier Scientific Publishing Company.
2. Orlov, D. S. (1992). *Soil chemistry*. AA Balkema Publishers.
3. Pinto, E., Aguiar, A. A. and I.M. Ferreira. (2014). Influence of soil chemistry and plant physiology in the phytoremediation of Cu, Mn, and Zn. *Critical reviews in plant sciences*, 33(5), 351-373.
4. Sposito, G. (1984). *The surface chemistry of soils*. Oxford university press.
5. Tan, K. H. (2010). *Principles of soil chemistry*. CRC press.

Part-Time Ph.D. (External) in Agribusiness management COURSE STRUCTURE AT A GLANCE

S. No.	Course No.	Course title	Credit hours
1.	23AG3270	ADVANCES IN MARKETING MANAGEMENT	3+0
2.	23AG3271	ENTREPRENEURSHIP IN AGRIBUSINESS	3+0
3.	23AG3272	ADVANCED AGRIBUSINESS MANAGEMENT	3+0
4.	23AG3273	MULTIVARIATE ANALYSIS AND SCALING TECHNIQUES IN SOCIAL SCIENCES	2+0
5.	23AG3274	MARKETING STRATEGY	2+0
6.	23AG3275	CONSUMER BEHAVIOUR	2+0

23AG3270 ADVANCES IN MARKETING MANAGEMENT

Credits: 3:0:0

Course Objectives

To impart Knowledge on:

1. Recent trends and advances in marketing research and management.
2. The skills required to develop, execute, and manage successful marketing strategies with a special focus on Bottom of Pyramid (BOP) markets.
3. Technological, environmental, and economic problems associated with marketing activities.

Course Outcome

At the end of this course, students will be able to:

1. Devise a marketing strategy based on the knowledge of BOP ventures and customer behaviour.
2. Attain analytical skills enabling them to systematically analyze and solve marketing problems for new and existing products.
3. Undertake the challenges and complexities involved in marketing management related to agro based industrial issues, problems and challenges.
4. Distinguish between market segmentation, market targeting, and brand equity in the market planning process.
5. Explore positioning, differentiation, and pricing strategies for effective marketing scenarios at Regional, National and International levels.
6. Analyze the impact of trade policies on export/ import of agri-business development.

Emerging markets Low-income markets / bottom of the pyramid – nature of the BOP market – products and services for BOP – market analysis – consumer characteristics – marketing strategy – BOP global opportunities. Brand management Branding strategies – brand positioning and values – building brand equity – brand equity assessment – leveraging secondary brand knowledge – building global brands. Marketing strategy Developing marketing strategies and plans – strategic marketing planning process – marketing ethics – analysing the marketing environment – socially responsible marketing. Marketing models multi-level marketing – business to business marketing – direct marketing – advances in electronic marketing – networking and e-marketing models. International marketing management Assessing global markets – strategies and ethical issues in global marketing – trade policies – instruments, impacts of trade policies – economic integration and regional grouping.

References

1. Alan, W., Valarie A. Z., Mary Jo Bitner and D. D. Grumbler (2012). *Services Marketing*, McGraw Hill Education publication
2. Gupta, C.B., and R. Nair (2004). *Marketing Management*, Sultan Chand and Sons, New Delhi.
3. Nancy R. Lee and P. Kotler (2011). *Social Marketing: Influencing Behaviors for Good*, SAGE Publications.
4. Nikolaos D., Neda J. D. and J. Ney. (2018). *Advanced Marketing Management: Principles, Skills and Tools*. Kogan Page, London.
5. Philip K., Kevin L.K., Swee H.A., Chin Tiong Tan, and Siew Meng Leong. (2018). *Marketing management: an Asian perspective*, Pearson, London.
6. Stephen P., Robbins, Mary C., David De Cenzo (2016). *Fundamentals of Management*, Pearson Publication.

23AG3271 ENTREPRENEURSHIP IN AGRIBUSINESS

Credits: 3:0:0

Course Objectives

To impart knowledge on:

1. Types and theories of entrepreneurship
2. Business facts and concepts used in the agri-business industry from production to marketing, that help to start an agri-business.
3. Role of MSMEs in promoting entrepreneurship and the institutional support to entrepreneurs.

Course Outcomes

On completion of this course, students will be able to:

1. Identify the gaps in production and promote agri-business projects with potential market demand ventures.
2. Apply and practice the basic theories of entrepreneurship and effective leadership strategies.
3. Promote social entrepreneurship and intrapreneurship.
4. Comply with statutory regulations and government policies for MSMEs.
5. Analysing factors influencing industrial sickness and developing measures to overcome.
6. Initiate Startups and Business ventures in agriculture sector.

Introduction, types - entrepreneurship, factor affecting entrepreneurship growth, entrepreneurship development programmes (EDPs), Theories of Entrepreneurship: Innovation Theory by Schumpeter and Imitating Entrepreneur Theory of Hoselitz, Theory of High Achievement by McClelland, X-Efficiency Theory by Liebenstein, Theory of Profit by Knight, Behavioural Approach Theory, Spill Over theory,

Entrepreneurial Learning, Heuristics and Venture creation theory, Theory of Social change by Everett Hagen. Innovation in entrepreneurship - concepts, principles, sources of Innovation opportunities and entrepreneurship strategies. Intrapreneurship – concepts, difference between intrapreneurship and entrepreneurship, process, dimensions, barriers and intrapreneurship organisation. Social entrepreneurship – characteristics, scope, objectives and principles, models, process and its impact. Government Policy for MSMEs, growth strategies in small scale enterprises, sickness in small enterprises, e-commerce and small enterprises

References

1. Badi, R.V. and N.V. Badi (2007). *Entrepreneurship*. Delhi: Vrinda publication (p) Ltd.
2. David H. H. (2008). *Entrepreneurship: New Venture Creation*. New Delhi: PHI.
3. Frank M. and M. Thompson (2010). *Social Enterprise- Developing Sustainable Businesses*. Palgrave Macmillan. ISBN: 978-0-230-20372-3.
4. Kuratko, D. F. (2016). *Entrepreneurship: Theory, process, and practice*. Cengage learning, United States.
5. Lall, M. and S. Sahai (2006). *Entrepreneurship*. New Delhi : Excel books.
6. Vasant, D. (2001). *Dynamics of Entrepreneurship Development*, New Delhi: Himalaya Publishers.

Websites

1. www.Entrepreneurdumonde.org
2. <http://www.smallbusinessnotes.com/choosing/intrapreneurship.html>
3. <http://www.pinchot.com/MainPages/BooksArticles/InnovationIntrapreneuring/SeniorMgrs.html>

23AG3272 ADVANCED AGRIBUSINESS MANAGEMENT

Credits: 3:0:0

Course Objectives

To impart knowledge on:

1. Agri-business in India and its focus on sustainable growth.
2. Business facts, concepts and models used in the agriculture industry from production to wholesale and retail markets.
3. Supply / Value chain management, option of restructuring the chains and government interventions in trade policies.

Course Outcomes:

On completion of this course, students will be able to:

1. Analyse various business models and trends in agribusiness sector.
2. Describe forward and backward linkages in agribusiness.
3. Analyse quality in supply chain management and strategies to achieve them.
4. Tackle issues of logistics in agribusiness.
5. Formulate and implement Warehouse Best Practices and Strategies.
6. Analyse the industrial reforms and relate it to Public Private Partnership.

Agribusiness in India – Status, Agro based industries – role and contribution to agribusiness, Global Trends, Emerging business models, Opportunities and Challenges, Strategic thinking in agribusiness. Status and performance of Important Agribusiness Sectors – Seed, Fertilizer, Agrochemicals, Farm Machinery and Implements, Irrigation equipment. Agriculture based service industry. Food and Agro Processing sectors – overview and issues. Food grain markets – Commodity Market Analysis. Strategic sourcing – Contract buying, retail buying, state and institutional purchasing, international buying, make or buy, negotiations, value analysis – measuring purchasing performance. Quality Management – 5S, Kaizen, Seven QC tools. Logistics – Packaging, Transportation, Warehousing, Cold Chain Warehousing. Supply Chain Management in agribusiness. Value Chain Analysis. Exports and Imports of agricultural commodities – Government policies on export and import - WTO regulations related to agribusiness. Government intervention and policies for agribusiness development, Public private partnership models.

References

1. Alexander, S. and D. Hallam (2012). *Agricultural Commodity Markets and Trade – New Approaches to Analysing Market Structure and Instability*, Pearson Ed, New York.
2. Barnard, F. L., Foltz, J., Yeager, E. A., and B. Brewer (2020). *Agribusiness management*. Routledge.
3. David H. Holt. (2008). *Entrepreneurship: New Venture Creation*. New Delhi: PHI.

4. John Ferris (2012). *Agricultural Prices and Commodity Market Analysis*, Michigan State University, Press, USA.
5. Kuratko, D. F. (2016). *Entrepreneurship: Theory, process, and practice*. Cengage learning, United States.
6. Sunil C., Peter M. and D.V.Kalra (2010). *Supply Chain Management – Strategy, Planning and Operation*, Pearson/PHI, 4th Edition, New Delhi.

23AG3273 MULTIVARIATE ANALYSIS AND SCALING TECHNIQUES IN SOCIAL SCIENCES

Credits: 2:0:0

Course Objectives

To impart knowledge on:

1. Statistical background to work on various techniques on multivariate analysis and development of models.
2. Analysis and interpretation of the results with conclusions from a multivariate analysis study.
3. Data reduction techniques, Discriminant analysis and various Clustering methods.

Course Outcomes

On completion of this course, students will be able to:

1. Develop the measurement scales of behavioural attitude.
2. Measure the reliability and validation of scales developed.
3. Test and interpret the statistical hypothesis.
4. Apply multivariate regression techniques in Social sciences.
5. Apply and analyse various methods of data reduction.
6. Perform and interpret Discriminant analysis and cluster analysis.

Multivariate statistical techniques – Multivariate regression model – step-up and step-down regression – Logit and Probit regression – Canonical correlations. Data Reduction – principal component analysis – extraction of principal components – interpretation - factor analysis – nature of factor analysis – basic concepts – assumptions of factor analysis – factor loadings – calculated rotated values – communalities - varimax rotation. Discriminant analysis – simple Cluster analysis – hierarchical clustering – k means clustering - Reliability analysis – path analysis Attitude – concept, methods of assessing attitude, direct questioning and direct observation of behaviour. Attitude statements – criteria of writing attitude statements, steps to be followed, writing, editing. Attitude scale construction methods – Paired Comparison - Equal Appearing Interval - Successive Interval. Attitude scale construction methods - Summated Rating - Scalogram Analysis - Scale Discrimination Analysis. Reliability and Validity of scales – testing, multi-dimensional scaling technique.

References

1. Anderson, T. (2003). *An Introduction to Multivariate Statistical Analysis*.
2. Bartholomew D. J and M. Knott (1999). *Latent Variable Models and Factor Analysis*.
3. Bartholomew. D. J, Steele F., Moustaki. I and J.I.Galbraith (2008). *Analysis of Multivariate Social Science Data*.
4. Ingwer B. and J.F.Patrick (2005). *Modern Multidimensional Scaling*.
5. Richard A. J. and W.W.Dean (2007). *Applied multivariate statistical analysis*.
6. Spencer, B. and D. Bowers (1976). *An Introduction to Multivariate Techniques for Social and Behavioural Sciences*.

23AG3274 MARKETING STRATEGY

Credits: 2:0:0

Course Objectives

To impart knowledge on:

1. Perspectives, challenges and strategies in rural market structure.
2. Evaluation of Customer Relationship management (CRM) and Market Performance Measurement.
3. Nature and qualities of e-Retailing.

Course Outcomes

On completion of this course, students will be able to:

1. Analyse the rural marketing structure.
2. Describe the consumer choice and behaviour.
3. Examine the different formats of retailing.

4. Explain the various marketing strategies followed in rural retailing.
5. Use metrics for measuring the performance\ efficiency of rural markets.
6. Conduct rural market research and adopt relevant development strategies.

Theory

Rural market structure – Perspectives of rural market- Challenges in Rural Marketing and strategy - Rural research. Consumer Choice and Shopping Strategies: Retail formats and strategies, Evaluating retail strategies and identifying critical success factors (CSFs): Store efficiency. Retail space and format planning: In-store customer behavior -optimizing space and store performance. International Retailing: expansion - internationalization process- Entry Behavior, e-Retailing: nature, atmospheric qualities of e-Retailing. Supply Chain Management and Retailer Performance: supply chain partners to create superior value and competitive advantages in the marketplace. Developing a CRM Strategy - Value Creation Process - CRM and Strategic Marketing – Marketing performance measurement

References

1. David W. C. and N. F. Percy.F. (2009) *Strategic Marketing* – 9th Ed', McGraw Hill – Irwin Publications, New York.
2. Dixit and Sinha (2016). *E-Retailing Challenges and Opportunities in the Global market place*. IGI Global publications, Pennsylvania, USA
3. Ferrell .O . C. and M. D. Hartline. (2011) *Marketing strategy* – Text and Cases – 6th Ed', South – Western Publications, Wisconsin, US
4. Fifield, P. (2012). *Marketing strategy*. Routledge, UK.
5. Max F. (2018) *The Art of CRM: Proven strategies for modern customer relationship management*, Packt Publishing
6. Michael, H. (2018). *Essentials of supply chain management*, Wiley Publications, New Jersey
7. Schlegelmilch, B. B. (2022). *Global marketing strategy*. Springer International Publishing.

23AG3275 CONSUMER BEHAVIOUR

Credits: 2:0:0

Course Objectives

To impart knowledge on:

1. Factors affecting consumer behaviour.
2. Behavioural pattern of consumers affecting marketing strategies.
3. Consumer decision process and adoption techniques of consumer behaviour.

Course Outcomes

On completion of this course, students will be able to:

1. Identify and analyse the major influences in consumer behaviour.
2. Distinguish between different consumer behaviour and their relationships.
3. Arrive at judicious marketing decisions based on the theories and concepts of consumer behaviour.
4. Recognise social and ethical implications of marketing actions on consumer behaviour.
5. Measure the adoption, resistance and diffusion of innovations.
6. Apply appropriate techniques to solve market issues and problems.

Consumer behaviour- Theories of consumer behaviour-Factors affecting consumer behavior-Marketing implications of consumer behavior. Motivation, ability and opportunity-Exposure, Attention and Perception-Knowledge and Understanding. Judgment and decision making based on high effort and low effort- Post decision process. Adoption, Resistance and Diffusion of Innovation-Symbolic consumer behaviour.

References

1. Batra, S. K. and S. H.H. Kazmi (2009). *Consumer Behaviour*-2nd. Excel Books India.
2. Jisana, T. K. (2014). *Consumer behaviour models: an overview*. Sai Om Journal of Commerce & Management, 1(5), 34-43.
3. Meenu, A. (2009). *Consumer Behaviour and rural marketing in India*, New century publications
4. Micheal, R.S. (2019). *Consumer Behaviuor: Buying, having and being*. Pearson Education Singapore Pvt Ltd.
5. Peter J. P. and C. J. Olson. (2005). *Consumer Behaviour and Marketing Strategy*. Tata McGraw Hill Publishing Company Limited.
6. Ramesh Kumar (2017) *Consumer Behaviour : The Indian context* , Pearson Education Singapore Pt Ltd.
7. Sethna, Z. and J. Blythe (2019). *Consumer behaviour*. Sage.

**DEPARTMENT OF
AGRICULTURE**

LIST OF NEW COURSES

S.No.	Discipline	Course Code	Name of the Course	Credits
1.	AGR	21AG2012	Weed Management- Elective Course 2	3 (2+1)
2.	AGR	22AG2013	Geoinformatics, Nano-technology and Precision Farming	2(1+1)
3.	Non-Gradual	22AG1012	NCC (Non -Gradual)	1(0+1)
4.	AEC	22AG2056	Statistical Methods	2(1+1)
5.	AEX	22AG2108	Entrepreneurship Development and Business Communication	2(1+1)
6.	SAC	22AG2308	Agrochemicals - Elective Course 3	3(2+1)
7.	AGR	22HO2275	Landscaping -Elective Course 1	3(2+1)
8.		21AG3994	Doctoral Research I	19(0+19)
9.		21AG3995	Doctoral Research II	19(0+19)
10.		21AG3996	Doctoral Research III	19(0+19)
11.		21AG3997	Doctoral Research IV	18(0+18)
12.		21HO3994	Doctoral Research I	19(0+19)
13.		21HO3995	Doctoral Research II	19(0+19)
14.		21HO3996	Doctoral Research III	19(0+19)
15.		21HO3997	Doctoral Research IV	18(0+18)
16.		21AG3998	Masters Research I	15(0+15)
17.		21AG3999	Masters Research II	15(0+15)
18.		21HO3998	Masters Research I	15(0+15)
19.		21HO3999	Masters Research II	15(0+15)
20.	AGR	21AG3240	Advances in Agro-Meteorology	3(3+0)
21.	AGR	21AG3241	Advances in Weed Management	3(3+0)
22.	AGR	21AG3242	Crop Water Requirements and Irrigation Scheduling	3(3+0)
23.	AGR	21AG3243	Advances in Cropping and Farming Systems	2(2+0)
24.	AGR	21AG3244	Advances in Crop Production and System Modeling	2(2+0)
25.	AGR	21AG3245	Advances in Soil Fertility and Crop Management	2(2+0)
26.	GPB	21AG3246	Genomics Assisted Breeding in Crops	3(3+0)
27.	GPB	21AG3247	Cytogenetics and Chromosome Manipulation in Crops	3(3+0)
28.	GPB	21AG3248	Advanced Plant Breeding Systems	3(3+0)
29.	GPB	21AG3249	Biometrical Techniques in Crop Improvement	2(2+0)
30.	GPB	21AG3250	Plant Genetic Resources and Its Importance	2(2+0)
31.	GPB	21AG3251	Breeding For Stress and Quality Traits	2(2+0)
32.	AEN	21AG3252	Advanced Insect Taxonomy	3(3+0)
33.	AEN	21AG3253	Insect Toxicology	3(3+0)
34.	AEN	21AG3254	Host Plant Resistance	3(3+0)
35.	AEN	21AG3255	Biotechnological Approaches in Entomological Research	2(2+0)
36.	AEN	21AG3256	Integrated Insect Pest Management	2(2+0)
37.	AEN	21AG3257	Biological Control of Insect Pests	2(2+0)
38.	PAT	21AG3258	Advanced Mycology	3(3+0)
39.	PAT	21AG3259	Advanced Virology	3(3+0)
40.	PAT	21AG3260	Advanced Bacteriology	3(3+0)

41.	PAT	21AG3261	Molecular Basis of Host-Pathogen Interaction	2(2+0)
42.	PAT	21AG3262	Plant Biosecurity and Biosafety	2(2+0)
43.	PAT	21AG3263	Principles and Procedures of Certification	2(2+0)
44.	FSC	21HO3270	Production Technology Trends in Fruit Crops	3(3+0)
45.	FSC	21HO3271	Advances in Growth Physiology of Fruit Crops	3(3+0)
46.	FSC	21HO3272	Fruit Crop Improvement	3(3+0)
47.	FSC	21HO3273	Genetic Resource Informatics in Horticulture	2(2+0)
48.	FSC	21HO3274	Stress Management in Horticultural Crops	2(2+0)
49.	FSC	21HO3275	Environmental Science in Relation to Horticulture	2(2+0)
50.	FLA	21HO3276	Recent Trends in Flower Cultivation Practices	3(3+0)
51.	FLA	21HO3277	Recent Trends in Breeding of Flower Crops	3(3+0)
52.	FLA	21HO3278	Advances in Landscape Architecture	3(3+0)
53.	FLA	21HO3279	Recent Trends in Protected and Precision Floriculture	2(2+0)
54.	FLA	21HO3280	Recent Trends in Biochemistry and Biotechnology of Flowers	2(2+0)
55.	FLA	21HO3281	Control of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)
56.	VEG	21HO3282	Recent Trends in Vegetable Production	3(3+0)
57.	VEG	21HO3283	Recent Trends Breeding of Vegetable Crops	3(3+0)
58.	VEG	21HO3284	Protected Cultivation of Vegetable Crops	3(3+0)
59.	VEG	21HO3285	Biotechnology in Vegetable Crops	2(2+0)
60.	VEG	21HO3286	Seed Certification, Processing and Storage of Vegetable Crops	2(2+0)
61.	VEG	21HO3287	Control of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)
62.	PSM	21HO3288	Advances in Production Technology of Plantation Crops	3(3+0)
63.	PSM	21HO3289	Advances in Production Technology of Spice Crops	3(3+0)
64.	PSM	21HO3290	Advances in Production Technology of Medicinal and Aromatic Crops	3(3+0)
65.	PSM	21HO3291	Advances in Breeding Methods of Plantation and Spice Crops	2(2+0)
66.	PSM	21HO3292	Advances in Breeding Methods of Medicinal and Aromatic Crops	2(2+0)
67.	PSM	21HO3293	Advances in Biotic and Abiotic Stress Management in Horticultural Crops	2(2+0)
68.	PHT	21HO3294	Novel Processing Technologies for Horticultural Produce	3(3+0)
69.	PHT	21HO3295	Advances in Laboratory Techniques in Post-Harvest Technology	3(3+0)
70.	PHT	21HO3296	Management of Storage and Supply/Cold Chain Techniques of Horticultural Produce	3(3+0)
71.	PHT	21HO3297	Advances in the Physiology Ripening and Senescence	2(2+0)
72.	PHT	21HO3298	Management of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)

73.	PHT	21HO3299	Innovative Packaging Technology for Horticultural Produce	2(2+0)
74.	AGR	21AG3229#	Simulation Techniques	2(1+1)
75.	AGR	21AG3230#	Sample Surveys	3(2+1)
76.	AGR	21AG3231#	Weather Forecasting	3(2+1)
77.	GPB	21AG3234#	Advances in Seed Science Research	1(1+0)

*Remedial course #Supporting courses for Ph.D.

Part-Time Ph.D. (External) in Agronomy
COURSE STRUCTURE AT A GLANCE

CODE	COURSE TITLE	CREDITS
21AG3240	Advances in Agro-Meteorology	3(3+0)
21AG3241	Advances in Weed Management	3(3+0)
21AG3242	Crop Water Requirements And Irrigation Scheduling	3(3+0)
21AG3243	Advances in Cropping And Farming Systems	2(2+0)
21AG3244	Advances in Crop Production And System Modeling	2(2+0)
21AG3245	Advances in Soil Fertility And Crop Management	2(2+0)

Part-Time Ph.D. (External) in Genetics & Plant Breeding
COURSE STRUCTURE AT A GLANCE

CODE	COURSE TITLE	CREDITS
21AG3246	Genomics Assisted Breeding iHOn Crops	3(3+0)
21AG3247	Cytogenetics and Chromosome Manipulation in Crops	3(3+0)
21AG3248	Advanced Plant Breeding Systems	3(3+0)
21AG3249	Biometrical Techniques in Crop Improvement	2(2+0)
21AG3250	Plant Genetic Resources and Its Importance	2(2+0)
21AG3251	Breeding For Stress and Quality Traits	2(2+0)

Part-Time Ph.D. (External) in Entomology
COURSE STRUCTURE AT A GLANCE

CODE	COURSE TITLE	CREDITS
21AG3252	Advanced Insect Taxonomy	3(3+0)
21AG3253	Insect Toxicology	3(3+0)
21AG3254	Host Plant Resistance	3(3+0)
21AG3255	Biotechnological Approaches in Entomological Research	2(2+0)
21AG3256	Integrated Insect Pest Management	2(2+0)
21AG3257	Biological Control Of Insect Pests	2(2+0)

Part-Time Ph.D. (External) in Plant Pathology
COURSE STRUCTURE AT A GLANCE

CODE	COURSE TITLE	CREDITS
21AG3258	Advanced Mycology	3(3+0)
21AG3259	Advanced Virology	3(3+0)
21AG3260	Advanced Bacteriology	3(3+0)
21AG3261	Molecular Basis of Host-Pathogen Interaction	2(2+0)
21AG3262	Plant Biosecurity and Biosafety	2(2+0)
21AG3263	Principles and Procedures of Certification	2(2+0)

Part time Ph.D. (External) in Horticultural Science (Fruit Science)
COURSE STRUCTURE AT A GLANCE

Code	COURSE TITLE	Credits
21HO3270	Production Technology Trends in Fruit Crops	3(3+0)
21HO3271	Advances in Growth Physiology of Fruit Crops	3(3+0)
21HO3272	Fruit Crop Improvement	3(3+0)

21HO3273	Genetic Resource Informatics in Horticulture	2(2+0)
21HO3274	Stress Management in Horticultural Crops	2(2+0)
21HO3275	Environmental Science in Relation to Horticulture	2(2+0)

**Part time Ph.D. (External) in Horticultural Science
(Floriculture and Landscape Architecture)
COURSE STRUCTURE AT A GLANCE**

Code	COURSE TITLE	Credits
21HO3276	Recent Trends in Flower Cultivation Practices	3(3+0)
21HO3277	Recent Trends in Breeding of Flower Crops	3(3+0)
21HO3278	Advances in Landscape Architecture	3(3+0)
21HO3279	Recent Trends in Protected and Precision Floriculture	2(2+0)
21HO3280	Recent Trends in Biochemistry and Biotechnology of Flowers	2(2+0)
21HO3281	Control of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)

**Part time Ph.D. (External) in Horticultural Science (Vegetable Science)
COURSE STRUCTURE AT A GLANCE**

Code	COURSE TITLE	Credits
21HO3282	Recent Trends in Vegetable Production	3(3+0)
21HO3283	Recent Trends in Breeding of Vegetable Crops	3(3+0)
21HO3284	Protected Cultivation of Vegetable Crops	3(3+0)
21HO3285	Biotechnology in Vegetable Crops	2(2+0)
21HO3286	Seed Certification, Processing and Storage of Vegetable Crops	2(2+0)
21HO3287	Control of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)

**Part time Ph.D. (External) in Horticultural Science
(Plantation, Spices, Medicinal and Aromatic Plants)
COURSE STRUCTURE AT A GLANCE**

CODE	COURSE TITLE	CREDITS
21HO3288	Advances in Production Technology of Plantation Crops	3(3+0)
21HO3289	Advances in Production Technology of Spice Crops	3(3+0)
21HO3290	Advances in Production Technology of Medicinal and Aromatic Crops	3(3+0)
21HO3291	Advances in Breeding Methods of Plantation and Spice Crops	2(2+0)
21HO3292	Advances in Breeding Methods of Medicinal and Aromatic Crops	2(2+0)
21HO3293	Advances in Biotic and Abiotic Stress Management in Horticultural Crops	2(2+0)

**Part time Ph.D. (External) in Horticultural Science (Post-Harvest Management)
COURSE STRUCTURE AT A GLANCE**

CODE	COURSE TITLE	CREDITS
21HO3294	Novel Processing Technologies for Horticultural Produce	3(3+0)
21HO3295	Advances in Laboratory Techniques in Post-Harvest Technology	3(3+0)
21HO3296	Management of Storage and Supply/Cold Chain Techniques of Horticultural Produce	3(3+0)
21HO3297	Advances in the Physiology Ripening and Senescence	2(2+0)
21HO3298	Management of Biotic and Abiotic Stress in Horticultural Crops	2(2+0)
21HO3299	Innovative Packaging Technology for Horticultural Produce	2(2+0)

LIST OF REVISED COURSE OUTCOMES

Sl. No.	Discipline	Course Code	Name of the Course	Credits
1	AGR	21AG1001	Fundamentals of Agronomy	4(3+1)
2	SAC	21AG1301	Fundamentals of Soil Science	3(2+1)
3	SAC	21AG2305	Renewable Energy and Green Technology	2(1+1)

4	SAC	21AG2306	Manures, Fertilizers and Soil Fertility Management	3(2+1)
5	SAC	21AG2307	Problematic Soils and Their Management	2(2+0)
6	SAC	21HO1302	Fundamentals of Soil Science	2(1+1)
7	SAC	21HO2306	Soil Fertility and Nutrient Management	2(1+1)
8	AEN	21AG1151	Fundamentals of Entomology	4(3+1)
9	AEN	21AG2153	Management of Beneficial Insects	2(1+1)
10	PAT	21AG2354	Principles of Integrated Pest and Disease Management	3(2+1)
11	GPB	21AG2203	Principles of Seed Technology	3(1+2)

21AG1001 FUNDAMENTALS OF AGRONOMY

Credits: 3:0:1 (3+1)

Course Objectives:

To impart knowledge on

1. Cultivation of crops, growing seasons, and crop classification
2. Planting, growth and development, crop nutrition, fertilizer recommendation and weed management
3. Crop rotation, distribution and adaptation, crop management, harvesting and threshing of crops

Course outcomes:

On completion of this course, students will be able to

1. Understand the history of agriculture, its branches, agronomy and its scope.
2. Acquire knowledge on tillage, types of tillage, tillage implements, seeds and sowing, crop geometry and density.
3. Learn crop classification, plant ideotypes, plant allelopathy, crop adaptation and distribution.
4. Study crop nutrition, weed management, herbicide use, growth and yield analysis and factors affecting growth.
5. Gain knowledge on Cropping systems, major cropping systems in India and Tamil Nadu and crop rotation.
6. Major crops of India and Tamil Nadu, their harvest and post harvest technology, storage and marketing.

21AG1301 FUNDAMENTALS OF SOIL SCIENCE

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Soil genesis and classification
2. Physical, chemical and biological properties of soil
3. Soil pollution and remediation measures

Course Outcomes:

On completion of this course, students will be able to

1. Explain soil genesis, pedological and edaphological concepts of soil.
2. Describe soil taxonomy, classification and soils of India.
3. Discuss and determine the physical properties of soil
4. Discuss and estimate the physio- chemical properties of soil
5. Describe the biological properties of soil and its influence on soil health
6. Analyze the behaviour of soil pollutants and recommend suitable remedial measures.

21AG2305 RENEWABLE ENERGY AND GREEN TECHNOLOGY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Concept of renewable energy.
2. The various green technology techniques.
3. Technical know-how on renewable energy measures.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the contributions of Renewable energy sources to agriculture

2. Describe the different types of biogas production structures
3. Demonstrate the various models of gasifiers
4. Gain basic knowledge of Biomass energy
5. Familiarize with the Solar energy and the Wind energy technologies
6. Design and analyse the renewable and green energy structures

21AG2306 MANURES, FERTILIZERS AND SOIL FERTILITY MANAGEMENT

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The properties and composition of organic manures and chemical fertilizers.
2. Chemistry of soil nutrients, plant nutrition and transport of nutrients in plant and soil.
3. Soil fertility evaluation and fertilizer recommendation methods.

Course Outcomes:

On completion of this course, students will be able to

1. Elucidate the properties of various organic manures and chemical fertilizers.
2. Explain the concepts of soil fertility and plant nutrition
3. Demonstrate the chemistry of macro and micro nutrients in soil.
4. Evaluate the fertility status of the soil and plant nutrient content
5. Describe the fertilizer recommendation approaches, methods of application and Integrated Nutrient Management
6. Analyze the factors influencing Nutrient Use Efficiency

21AG2307 PROBLEMATIC SOILS AND THEIR MANAGEMENT

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. Soil health and irrigation water quality standards and land classifications
2. Categorization, characterization and management of problem soils and waste lands.
3. Bio-remediation and applications of Remote sensing and GIS in diagnosis and management of problem soils.

Course Outcomes:

On completion of this course, students will be able to

1. Explain the concepts and indicators of soil quality and sustainable soil health.
2. Discuss the distribution of wastelands and problem soils in India.
3. Categorize and characterize the problematic soils and waste lands.
4. Recommend suitable reclamation and management practices for problem soils.
5. Describe the irrigation water quality standards and land capability/ suitability classifications
6. Appraise bio-remediation of soils and applications of remote sensing and GIS in the management of problem soils.

21HO1302 FUNDAMENTALS OF SOIL SCIENCE

Credit: 1:0:1 2(1+1)

Course Objectives:

To impart knowledge on

1. Soil genesis and classification
2. Physical, chemical and biological properties of soil
3. Soil pollution and remediation measures

Course Outcomes:

On completion of this course, students will be able to

1. Explain soil genesis, pedological and edaphological concepts of soil.
2. Describe soil taxonomy, classification and soils of India.
3. Discuss and determine the physical properties of soil
4. Discuss and estimate the physio- chemical properties of soil
5. Describe the biological properties of soil and its influence on soil health
6. Analyze the behaviour of soil pollutants and recommend suitable remedial measures.

21HO2306 SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The properties and composition of organic manures and chemical fertilizers.
2. Chemistry of soil nutrients, plant nutrition and transport of nutrients in plant and soil.
3. Soil fertility evaluation and fertilizer recommendation methods.

Course Outcomes:

On completion of this course, students will be able to

1. Elucidate the properties of various organic manures and chemical fertilizers.
2. Explain the concepts of soil fertility and plant nutrition
3. Demonstrate the chemistry of macro and micro nutrients in soil.
4. Evaluate the fertility status of the soil and plant nutrient content
5. Describe the fertilizer recommendation approaches, methods of application and Integrated Nutrient Management
6. Analyze the factors influencing Nutrient Use Efficiency

21AG1151 FUNDAMENTALS OF ENTOMOLOGY

Credits: 3:0:1 (3+1)

Course objectives:

To impart knowledge on

1. Insect morphology, anatomy, and physiology
2. Insect systematics
3. Insect ecology, classification of pesticides and concept of different pest management techniques

Course outcomes:

On completion of this course, students will be able to

1. Understand the origin and evolution of Insects
2. Understand the insect external body parts and their modifications
3. Remember the insect orders and families of agriculturally important pests
4. Understand the anatomy of internal organs and their functions
5. Analyze the factors influencing pest occurrence
6. Apply the fundamental knowledge on insects in their effective and integrated management strategies

21AG2153 MANAGEMENT OF BENEFICIAL INSECTS

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The importance of beneficial insects and their characteristics.
2. Mulberry cultivation and silkworm rearing using innovative techniques.
3. Bee keeping techniques and mass culturing of predators and parasitoids.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of beneficial insects in agriculture and can identify the different beneficial insects
2. Remember the morphology, physiology, and biology of beneficial insects and cultivation practices of mulberry
3. Understand and demonstrate the various appliances and skills involved in apiculture, sericulture, lac culture and mass production of predators and parasitoids
4. Understand the harvesting and processing methods of honeybee products, silk, and lac and their uses
5. Analyze the opportunities and risks such as pests and disease incidence in production of beneficial insects and can manage them
6. Apply the knowledge and create entrepreneurial ventures of bee keeping, silkworm rearing, lac culture and bio control agents' production

21AG2354 PRINCIPLES OF INTEGRATED PEST AND DISEASE MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The various categories of economically important pest and diseases and their identification and diagnosis methods
2. Principles of insect pest and disease management, including concepts, importance, tools and constraints of IPM.
3. Computation of ETL, AESA based IPM and implementing IPM programs.

Course Outcomes:

On completion of this course, students will be able to

1. Remember the important concepts and principles of Integrated pest and disease management practices
2. Understand and demonstrate the various tools of IPM - Cultural, Mechanical, Physical, Biological, Legal and Chemical control
3. Apply the knowledge to develop Integrated pest and disease management strategies
4. Analyze the pest outbreak through pest monitoring, forecasting and surveillance methods
5. Create the awareness among farmers about the importance of IPM and help them to implement the suitable IPM practices based on AESA
6. Evaluate the political, social, and legal implication of implemented IPM

21AG2203 PRINCIPLES OF SEED TECHNOLOGY

Credits 1:0:2 (1+2)

Course Objectives:

To impart knowledge on

1. Seed structure and morphology, physical characteristics of seed.
2. Importance of seed and concepts of seed, its classification, certification, purity and Seed Act.
3. Seed storage, pest and disease control, seed distribution infrastructure and protocols in India.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of quality seed in agriculture production.
2. Distinguish types of seeds and know seed certification process.
3. Describe seed structure and morphology, physical characteristics of seed.
4. Conduct varietal identification, seed quality assessments tests and seed treatments.
5. Remember the concepts in seed storage and seed marketing

21AG2012 WEED MANAGEMENT

Credits 3 (2+1)

Course Objectives:

To impart knowledge on

1. Different types weeds and its impact on crop production
2. Herbicides and its application in weed control
3. Different methods of weed control in crop production.

Course Outcomes:

On completion of this course, students will be able to

1. Identify different types of weeds and their ecosystem
2. Understand the weeds survival mechanisms
3. Recommend herbicides understanding their effects on the crops
4. Adopt different weed control methods
5. Apply integrated weed management practices
6. Workout the economics of weed control in horticultural crops

Theory

Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicides and selectivity. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with agro-chemicals and

their application. Integration of herbicides with non-chemical methods of weed management. Herbicide Resistance and its management.

Practical

Techniques of weed preservation. Weed identification and their losses study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and agro-chemicals study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipments. Calculations of herbicide doses and weed control efficiency and weed index.

References

1. Gupta, O. P. 1998. Modern Weed Management. Agro Botanica Bikaner, India.
2. Jaganathan, R., and R. Jayakumar. 2003. Weed Science Principles, Kalyani Publishers, New Delhi.
3. Hance, R.J. and K. Holly. 1990. Weed Control Handbook: Principles. Blackwell Scientific Publications, Oxford, London
4. Musselman, L. J. 1987. Parasitic Weeds in Agriculture. Vol. I. Striga. CRO Press Inc. Florida, US.
5. Rao, V. S. 1983. Principles of Weed Science. Oxford and IBH Publishing Co. New Delhi.
6. Subramanian, S. A. Mohammed Ali and R. Jayakumar. 1991. All about Weed Control. Kalyani Publishers, New Delhi.

22AG2013 GEOINFORMATICS, NANO-TECHNOLOGY AND PRECISION FARMING

Credit 2 (1+1)

Course Objectives:

To impart knowledge on

1. The significance and concepts of precision agriculture
2. Geoinformatics and its application in precision farming
3. Nanotechnology and its role in precision farming

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concepts of precision farming.
2. Demonstrate the use of Unmanned Aerial Vehicle (UAV) in farm operations.
3. Enhance their understanding on Geoinformatic principles and the use of GIS, GPS, Sensors and Remote Sensing technologies in agriculture.
4. Relate the use of various Crop Simulation Models in crop production.
5. Apply the STCR approach for optimizing the fertilizer inputs in precision farming.
6. Acquire knowledge on nanotechnology and its uses for scaling-up farm productivity.

Theory

Precision farming - Introduction – concepts, importance, techniques and concerns for Indian agriculture. Introduction to drones/UAV, Types of drones, Application of drones in agriculture, standard operating procedures of drones. Geoinformatics - definition, concepts, tools and techniques; their use in precision agriculture. Sensors - Remote sensing concepts and application in agriculture. Introduction to Crop Simulation Models (CSM) and their uses in agriculture. STCR approach for precision agriculture. Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects, nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in agriculture for scaling-up farm productivity.

Practical

Introduction to GIS software - Introduction to image processing software - Introduction to GPS - Spraying drones and there operations - Greenhouse technology and different types of greenhouses - Basic components of greenhouses - Rooting media preparations for greenhouse production - Methods of disinfecting the rooting media for greenhouse crop management - Drip irrigation system for precision irrigation - Fertigation methods for precise nutrient management - Intelligent Irrigation System - Automated environmental control systems for greenhouses.

Reference:

1. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
2. Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.
3. Ancha Srinivasan. 2006. Handbook of precision agriculture principles and applications. The Haworth press. Binghamton. Inc., New York.

4. Tarun Kumar Upadhyay and Sushil Kumar Sharma. 2020. A Textbook on Geoinformatics, Nanotechnology and Precision Farming. ND Publisher, India.
5. Reddy S. R. 2020. Geoinformatics and Nanotechnology for Precision Farming. Kalayani Publ.
6. Dhaliwal, S.S., Naresh, R. K., Vivek, Sudhir Kumar, Vivak Kumar, Raj.K.Setia. 2020. Precision Farming: Geoinformatics and Nanotechnology. Jaya Publishing House, New Delhi, India.

22AG1012 NCC

Credits 1 (0+1)

National Cadet Corps I

1. Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
2. Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
3. Sizing, numbering, forming in three ranks, open and close order march and dressing.
4. Saluting at the halt, getting on parade, dismissing and falling out.
5. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear.
6. Turning on the march and wheeling. Saluting on the march.
7. Marking time, forward march and halt.
8. Changing step, formation of squad and squad drill.
9. Command and control, organization, badges of rank, honours and awards
10. Nation Building- cultural heritage, religions, traditions and customs of India. National integration.
11. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen.
12. Leadership traits, types of leadership. Character/personality development.
13. Civil defense organization, types of emergencies, fire fighting, protection,
14. Maintenance of essential services, disaster management, aid during development projects.
15. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
16. Structure and function of human body, diet and exercise, hygiene and sanitation.
17. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.
18. Adventure activities
19. Basic principles of ecology, environmental conservation, pollution and its control.
20. Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self defense.

National Cadet Corps II

1. Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.
2. Shoulder from the order and vice-versa, present from the order and vice-versa.
3. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa.
4. Guard mounting, guard of honour, Platoon/Coy Drill.
5. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting.
6. Loading, cocking and unloading. The lying position and holding.
7. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
8. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing.
9. Characteristics of Carbine and LMG.
10. Introduction to map, scales and conventional signs. Topographical forms and technical terms.
11. The grid system. Relief, contours and gradients. Cardinal points and finding north. Types of bearings and use of service protractor.
12. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map.
13. Knots and lashings, Camouflage and concealment, Explosives and IEDs.

14. Field defenses obstacles, mines and mine lying. Bridging, waterman ship
15. Field water supplies, tracks and their construction.
16. Nuclear, Chemical and Biological Warfare(NCBW)
17. Judging distance. Description of ground and indication of landmarks.
18. Recognition and description of target. Observation and concealment. Field signals. Section formations.
19. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
20. Types of communication, media, latest trends and developments.

22AG2056 STATISTICAL METHODS

Credits 2(1+1)

Course objectives:

To impart knowledge on

1. Acquire the knowledge of statistical methods.
2. Understand the process of using statistics in Agricultural problems.
3. Develop the skills of problem solving in Agriculture.

Course outcomes:

On completion of this course, students will be able to

1. Identify the applications of statistics to Agriculture.
2. Measure the central tendency and dispersion of Data.
3. Recognize the different probability distributions.
4. Utilize testing tools to verify hypothesis.
5. Design the experiments and make appropriate decisions.
6. Apply the skills of sampling in problem solving.

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 × 2 Contingency Table. Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 × 2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling.

Reference Books:

1. Veerarajan T, "Probability, Statistics and Random Processes", Second Edition, Tata McGraw Hill publishing company, 2003.
2. Gupta S.P., "Statistical Methods", New Delhi, S.Chand & Co., 37th Edition, 2009.
3. Gupta S.C. and Kapoor V.K., "Fundamentals of Applied Statistics", Sultan Chand & Co., 1990.
4. Gomez, K.A. and Gomez, A.A., "Statistical Procedures for Agricultural Research", John Wiley and Sons. New York. 1984.
5. Panse, V. G. and P.V. Sukhatme, "Statistical Methods for Agricultural Workers", Indian Council of Agricultural Research, New Delhi, India, 1967.

22AG2108 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS COMMUNICATION

Credits 2(1+1)

Course Objectives:

To impart knowledge on

1. Entrepreneurial spirit and orientation towards becoming an entrepreneur
2. Agri-business opportunities that are commercially successful and the procedures involved in start-ups
3. The art and science of business plan and project formulation

Course Outcomes:

On completion of this course, students will be able to

1. Distinguish different entrepreneurial traits and skills
2. Know the agribusiness opportunities open for agriculture graduates
3. Apply the leadership skills to get financial support for start-ups
4. Understand the impact of economic reforms in agri-business
5. Perform SWOT analysis of an entity for any prospective agribusiness/ideas
6. Formulate business proposals for successful implementation of business plans

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation. Government policy, programs, and institutions for entrepreneurship development. Impact of economic reforms on Agribusiness/ Agri-enterprises, Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring and evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for Agri entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem-solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea. Preparation of business plan and proposal writing. Visit to local rural enterprise engaged in agribusiness (Agri out based based), Visit to local rural enterprise engaged in agribusiness (Agri input based) Art of raising fixed and working capital for the business - Interaction with bank managers funding entrepreneurs and agribusinesses. Visit to entrepreneurship development institute and studying their promotional activities.

Reference Books

1. Chopra, R.R., P.S. Kapse and P.R. Deshmukh. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur, India.
2. Singal, R.K. 2006. Entrepreneurship Development and Management. S. K. Kataria and sons, New Delhi, India.
3. Nandan, H. 2013. Fundamentals of Entrepreneurship. PHI publishers, New Delhi, India.
4. Sangeeta Sharma, 2016. Entrepreneurship Development. PHI Publishers, New Delhi.
5. Heady Earl, O and H. R. Jenson. 1954. Farm Management Economics. Prentice Hall, New Delhi.
6. Johl, S.S. and J.R. Kapur. 2006. Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi.
7. Karan Singh and A S. Kahlon 1981. Economics of Farm Management in India. Theory and Practice. Allied Publishers Pvt. Ltd, New Delhi.
8. Prasad. L.M. 2001. Principles and Practices of Management. 9th Ed. S. Chand and Sons, New Delhi.
9. Koontz Harold and Weihrich, Heinz, 2007. Essentials of. Management. Tata McGraw Hills, Education Private Limited, New Delhi.

22AG2308 AGROCHEMICALS

Credit: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Fundamental understanding of agrochemicals
2. Classification and mode of action of herbicides, insecticides, fertilizers and bio pesticide
3. Estimation and determination of major components in agrochemicals

Course Outcomes:

On completion of this course, students will be able to

1. Understand the role of agrochemicals for sustainable agriculture
2. Remember the classification and mode of action

3. Familiarize with manufacturing, marketing and logistics
4. Develop skills in calculation, formulations of insecticides
5. Evaluate need based recommendation for various crops
6. Disseminate the plant based bio pesticides for sustainable agriculture

Theory

An introduction to agrochemicals, their type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture. Herbicides -Major classes, properties and important herbicides. Fate of herbicides. Fungicides - Classification – Inorganic fungicides - characteristics, preparation and use of sulfur and copper, Mode of action-Bordeaux mixture and copper oxychloride. Organic fungicides- Mode of action - Dithiocarbamates - characteristics, preparation and use of Zineb and maneb. Systemic fungicides - Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use. Introduction and classification of insecticides: inorganic and organic insecticides Organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids Neonicotinoids, Biorationals, Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil & plant. IGRs Biopesticides, Reduced risk insecticides, Botanicals, plant and animal systemic insecticides their characteristics and uses. Fertilizers and their importance. Nitrogenous fertilizers: Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers. Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers: Natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate. Mixed and complex fertilizers: Sources and compatibility–preparation of major, secondary and micronutrient mixtures. Complex fertilizers: Manufacturing of ammonium phosphates, nitrophosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellent.

Practical

Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for identification of common fertilizers. Identification of anion and cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available in market. Estimation of nitrogen in Urea. Estimation of water soluble P₂O₅ and citrate soluble P₂O₅ in single super phosphate. Estimation of potassium in Muriate of Potash/ Sulphate of Potash by flame photometer. Determination of copper content in copper oxychloride. Determination of sulphur content in sulphur fungicide. Determination of thiram. Determination of ziram content.

References

1. Nene, Y.L. and Thapliyal, P.N.1993. Fungicides in Plant Diseases Control 4 th Edition. MEDTEC Publishers.
2. Parker and Harold.J.1991. Environmental handbook for fertilizer and agrichemical dealers. Tennessee Valley Authority, National Fertilizer and Environmental Research Center.
3. Panda, H. 2003. The complete technology Book on Pesticides, Insecticides, Fungicides and Herbicides with Formulae and Processes. Published by National Institute of Industrial Research, Delhi.

22HO2275 LANDSCAPING

Credits 3 (2+1)

Course Objectives:

To impart knowledge on

1. The scope and importance of landscaping
2. The principles, styles and types of landscaping
3. Ornamental plants used in landscaping and application of CAD in landscaping

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the principles of landscaping
2. Explain about the different styles and types of landscaping
3. Identify the ornamental plants used in landscaping
4. Prepare landscape plans for different environment
5. Enumerate the establishment and maintenance of bonsai plants and lawn
6. Apply CAD in preparing landscape plans

Theory

Importance and scope of landscaping. Principles of landscaping, garden styles and types, terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery, water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes. Trees: selection, propagation, planting schemes, canopy management, shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture. Climber and creepers: importance, selection, propagation, planting, Annuals: selection, propagation, planting scheme, other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement, management. Bio-aesthetic planning: definition, need, planning; landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions. Bonsai: principles and management, lawn: establishment and maintenance. CAD application.

Practical

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals, care and maintenance of plants, potting and repotting, identification of tools and implements used in landscape design, training and pruning of plants for special effects, lawn establishment and maintenance, layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software, visit to important gardens/ parks/ institutes.

References:

1. Bose TK, Maiti RG, Dhua RS & Das, P. 1999. Floriculture and Landscaping. NayaProkash
2. Nambisan KMP. 1992. Design Elements of Landscape Gardening. Oxford & IBH.
3. Grewal H.S and Parminder Singh. 2014. Landscape designing and ornamental plants
4. Peter. K.V.2009.Ornamental plants. New India publishing agency, Pitampura, New Delhi.
5. Rajesh Srivastava. 2014. Fundamentals of Garden designing. AgrotechPress, Jaipur, New Delhi.
6. Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries Pvt., Ltd.

ELP 012– FOOD PROCESSING

Guidelines for setting up a processing unit, acquaintance with equipments used in food processing units, analysis of physico chemical parameters in fruits and vegetables, post harvest treatments in fruits, vegetables and cut flowers, determination of ethylene evolution and respiration rate, sorting, grading and sizing of fruits and vegetables, packaging of food materials, preparation of dehydrated fruits and veggies, fruit bars, cold preservation by lyophilization, value addition: preparation of fermented beverages - wine and vinegar and preparation of non fermented beverages – RTS beverage, nectar and squash, preparation of intermediate moisture food – jam, jelly and marmalade, preservation by sugar – candies, preservation by salt – pickle, chutneys and sauce, minimal processing of fruits and vegetables, preparation of baked products – cakes, cookies and bread, visit to food processing units

References:

1. Morris, T.N. 2004. Principles of Fruit Preservation. Biotech Books, Delhi. 81-7622-116-3.
2. Rathore, N. S., G.K. Mathur, S.S. Chasta. 2012. Post-Harvest Management and Processing of Fruits and Vegetables. The Energy And Resources Institute.
1. Srivastava, R. P. and S. Kumar. 2002. Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co., Lucknow.
2. Verma, L.R. and V.K. Joshi. 2000. Postharvest Technology of Fruits and Vegetables. Indus Publishing Co., New Delhi.

ELP 014- COMMERCIAL SERICULTURE

Credits : { 0+ 20}

Unit 1: Grainage: Morphology of silkworm egg. Seed cocoon processing/handling – deflossing, sorting and preservation – pupal examination and sex separation of pupa and moth. Treatment of eggs with acid, acid preparation. Visit to seed cocoon markets, commercial grainage and cold storage centre to know activities of cocoon markets, preparation of laying and cold storage of eggs.

Unit 2: Post cocoon technology: Cocoon stifling (sun drying, steam stifling, hot air stifling), storage of cocoon, sorting of cocoons. Deflossing, cocoon riddling, mixing or blending, cocoon cooking, brushing. Concept of difference reeling machines, reeling operation, reeling end formation. Degumming, bleaching, dyeing of silk yarn .Twisting, Reeling, Re-reeling, lacing, skeining and testing of raw silk material Weaving of silk

Unit 3: General classification of textile fibers. Difference between nature and synthetic fibers according to their composition and properties. Identification of Silk Textile Fibers by Physical and Chemical Test: Microscopic Examination, Flame Test, Solubility Test; Longitudinal and cross section view of silk textile fibers and their impact on physiomechanical properties like tenacity, elongation toughness, elastic recovery and moisture absorption. Introduction and Objective of Degumming Methods. Silk Bleaching, Silk Dyeing – Acid and Basic Dyeing Processing. Introduction of Different Classes of Dyes and Chemicals used for Silk Dyeing.

Unit 4 Economics: Principles of economics, micro and macroeconomics; Unit 2: Advantages and characteristics of sericulture. Scope of sericulture in India – Vis-à- Vis other agricultural crops - income and employment generation. Economics of silkworm egg production in government and private grainage. Economics of mulberry production under rain-fed and irrigated systems; comparative economics of mulberry production under traditional and improved practices. Economics of raw silk production in charka, cottage basin and multi-end reeling units.

References:

1. Sonwalker, t.n. handbook of silk technology, new age international pvt., ltd
2. Kumaresan, p. And srinivasa, g. (2005) sericulture extension management and economics. Central silk board, bangalore.
3. Ganga, g., and j. Sulochana chetty. (1991) an introduction to sericulture. Oxford & ibh publishing
4. Manual on silkworm egg production, dr. M.n narasimhana
5. Morohoshi (2001). Development physiology of silkworms. Science publishers, u.s.
6. Silkworm crop protection, central silk board, bangalore, india

21AG3240 ADVANCES IN AGRO-METEOROLOGY

Credits: 3:0:0 (3+0)

Course Objectives:

To impart knowledge on

1. Agricultural meteorology and rainfall climatology
2. Climatological approaches in designing cropping systems and crop weather models
3. Micro climatology and GIS

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of agricultural meteorology, climate and weather
2. Enumerate climatological approaches in designing cropping systems
3. Understand crop weather relationships for efficient crop production and agro climate
4. Acquire knowledge on crop weather models
5. Describe various micro climate modification using crop geometry management
6. Discuss response farming and soil moisture dynamics

Theory

Scope of agro-meteorology - Past, Present and Future - Rainfall climatology - Tools - for India and Tamil Nadu - Moisture availability indices and water balance. Weather Forecasting - Practical implications on crop production - Climatological approaches in designing cropping systems - Crop weather models - Principles and methodology. Rainfall prediction models - concept and applications - Agroclimatic analysis: zonation and its applicability to SAT and crop production, use of remote sensing and GIS. Micro climatology - Impact on crop production - Micro climate modification using crop geometry management - Research review - Dry farming and Dry land research: historical perspectives, national and international significance. Drought management and Crop adaptation techniques to drought - Research studies - Response farming: concepts and applications - Soil moisture dynamics - approaches and models for soil profile moisture.

Suggested reading

1. Babu, D.N. and G.S.Gupta 1967. Agro Climatic Regional Planning in India, Concept Publishing Company, New Delhi.
2. Bazzaz. F. and W. Sombroek. 2005. Global climate change and agricultural production. Daya Publishing House, New Delhi.
3. Gopalaswamy ,N. 1994. Agricultural Meteorology Rawat Publication, Jaipur.
4. Jeevananda Reddy D.S 2002. Dryland Agriculture in India – An Agroclimatological and Agrometeorological Perspective. B.S. Publication, Hyderabad.
5. Lenka D. 2001. Climate, Weather and Crop in India, Kalyani Publishers, New Delhi. Mavi, H.S 1996 Introduction to Agrometeorology.
6. Shrivastava.A.K. 2007. Global Warming. APH publishing corporation, New Delhi.

7. Weekly rainfall probability for selected stations of India. Vol. I & Vol.II, IMD, Pune, Published by Addl. D.G. of meteorology.
8. Yash P.Abrol and Sulochana Gadgil 1996. Climate Variability and Agriculture, G.B.Pant Narosa Pub.House, New Delhi.

21AG3241 ADVANCES IN WEED MANAGEMENT

Credits: 3:0:0 (3+0)

Course Objectives:

To impart knowledge on

1. Weed management strategies and modern weed management techniques.
2. Herbicides and their selectivity.
3. Weed shift, herbicide resistant weeds and fate of herbicides in soil.

Course Outcomes:

On completion of this course, students will be able to

1. Identify the different types of weeds management strategies.
2. Understand the modern weed management techniques.
3. Enumerate mode of action of herbicides.
4. Understand herbicide selectivity.
5. Acquire knowledge on weed shift and fate of herbicides in soil.
6. Understand herbicide resistance and herbicide persistence.

Theory

Concepts of weed prevention, control and eradication - Weed management methods; concepts and principles: physical, cultural, chemical and biological methods - Integrated weed management - Modern Weed management - No tillage - minimal tillage - Conservation Agriculture - Solarisation - stale seed bed preparation - mulching -cropping system. Herbicide classification and its characteristics - Selectivity of herbicides in plants and their mechanism - Absorption and translocation of soil and foliar applied herbicides - Registration procedures. Mechanism and mode of action of herbicides in plants - Factors affecting the efficiency of herbicide; herbicide formulations, herbicide mixtures - Herbicide interaction with other inputs - Advances in herbicide application techniques. Weed management methods: Integrated weed management for major crops - Weed management in organic agriculture - Management of parasitic, aquatic and problem weeds - Weed shift and its management. Fate of herbicides in soil - Interaction with microorganisms - Herbicide persistence - Residue management - Herbicide resistant weeds and their management - Advances in biotechnology-herbicide tolerant crops-nanotechnological applications.

Suggested Readings

1. Chinnamuthu,C.R., B.Chandrasekaran and C.Ramasamy. 2008. Nanotechnology Applications in Agriculture. 2008. Published by the Directorate of Research, TNAU, Coimbatore. ISBN No.978-81-904337-3-0.
2. Dodge, A.D. 1989. Herbicides and Plant Metabolism. Cambridge Univ. Press, Cambridge, London.
3. Mandal, R.C. 1990. Weeds, Weedicides and Weed Control Principles and Practices. Bikaner India. Agro Botanical Publishers, India.
4. Mathews, G.A. 1979. Pesticide Application Methods. Longman Publishing Ltd, London.

Web readings

- <http://www.fao.org/docrep/006/y5031e/y5031e00.htm#Contents>
- <http://www.agrisk.umn.edu/cache/ARL02964.htm>
- <http://erec.ifas.ufl.edu/weeds/powerpoints/Basic%20Principles%20of%20Weed%20Management.pdf>
- <http://www.omafra.gov.on.ca/english/crops/pub811/12crop.htm>
- <http://www.eolss.net/sample-chapters/c10/E1-05A-31-00.pdf>
- <http://www.fao.org/docrep/006/y5031e/y5031e0j.htm>

21AG3242 CROP WATER REQUIREMENTS AND IRRIGATION SCHEDULING (3+0)

Credits: 3:0:0 (3+0)

Course Objectives:

To impart knowledge on

1. Climatological approach on irrigation scheduling.
2. Crop coefficient and irrigation water requirements of crops.
3. Irrigation scheduling and different approaches.

Course Outcomes:

On completion of this course, students will be able to

1. Identify the different types of climatological nomenclatures for ET.
2. Understand crop coefficient and its types.
3. Enumerate factors affecting water requirement.
4. Understand different methods of determining water requirement by crops.
5. Understand the relation between Irrigation Performance and Irrigation Scheduling.
6. Outline different indicators for irrigation scheduling.

Theory

Evaporation; Transpiration; Evapotranspiration; ET process - Factors Influencing ET; ET and Crop Yield; Computation of ET by Empirical Methods - Climatological Nomenclature, Blaney-Criddle Method, Radiation Method, Modified Penman Method; Penman Monteith method and Pan Evaporation Method - Calculation of ET of crop; Reference ET, Actual ET - Measurement of ET using Lysimeters and Evaporimeters. Crop Coefficient - Factors affecting crop coefficient - Types of Crop Coefficient - Selection Criteria for Single and Dual Crop Coefficients - Reference Evapotranspiration (ET_0) - Requisite Data - ET_0 by Pan Evaporation - ET_C at soil water stress condition. Water Requirement; Irrigation Requirement; Factors Affecting Water Requirement - Crop Factors, Soil Factors, Climatic Factors, Crop Management Practices; Methods of Determining Water Requirement - Transpiration Ratio Method, Depth - interval - yield Method, Water Balance Method, Field Experiments, Climatological Methods, Drum Culture Technique for Rice; Water Requirement of Different Crops; Effective Rainfall - Soil Moisture Balance Method. Irrigation Scheduling - Cereals, Millets, Pulses, Oilseeds, commercial crops, vegetables and fruit crops - Adjustments in Irrigation Schedule - Relation between Irrigation Performance and Irrigation Scheduling. Irrigation scheduling - different approaches - When to Irrigate - Soil Indicators (gravimetric method, feel and appearance, tensiometers, electrical resistance and water budget techniques), Plant Indicators (appearance and growth, leaf temperature, leaf water potential and stomatal resistance), Meteorological Indicators (IW / CPE ratio). Soil - cum - sand mini plot technique, increased population and can evaporimeter method.

Suggested readings

1. Dilip Kumar Majumdar, 2000. Irrigation water management: Principles and Practice. Prentice-Hall of India Private Limited, New Delhi-1.
2. Michael, A.M. 1997. Irrigation Theory and Practice. Vikas Publishing House Pvt. Ltd. New Delhi - 110 014.
3. Sankara Reddy and T.Yellamanda Reddy. 1997. Efficient use of Irrigation Water. Kalyan Publishers. New Delhi.
4. Suresh. R. 2010. Micro Irrigation, Theory and practices. Standard publishers, New Delhi, 695 p.
5. FAO. 1975. Crop water requirements FAO paper no 24. 179 p.
6. FAO. 1979. Yield response to water FAO paper no 33.
7. FAO. 1998. Crop evapotranspiration FAO paper no 56. 281 p.

Web reading

- www.weap21.org
- www.springerlink.com/content/u35k21u5548x7320
- www.tekla.com/international/products/tekla-xpipe
- www.dripirrigation.org
- www.netafim.com/
- www.jains.com
- www.rainbird.eu, www.fpil.in

21AG3243 ADVANCES IN CROPPING AND FARMING SYSTEMS

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. Cropping and Farming system.
2. Contingency crop planning and Alternate farming system.
3. Integrated farming system models for different agro eco-systems.

Course Outcomes:

On completion of this course, students will be able to:

1. Understand different cropping systems and ways to effectively manage resources under different cropping systems.
2. Develop deep insights on crop interactions under cropping systems.
3. Gain knowledge on alternate farming systems, no and low cost technologies
4. Calculating different farming system indices.
5. Imbibe knowledge on Integrated farming system models for different agro eco-systems.
6. Apply the knowledge of sustainable crop production in sustainable agriculture.

Theory

System approach – farming system: scope and advantages – crop Intensification and diversification - cropping system – need - terms and definition. Interaction in cropping system – competitiveness and complementary - resource management in farming system: tillage and land shaping - crops and variety - crop geometry - water management - soil fertility management – pest management - Post harvest management and value addition. Farm planning for different situations – Alternate farming system – monetary and non monetary inputs in farming - contingency crop planning – evaluation of farming system: yield advantage, land use efficiency - biological efficiency – productivity – economics, energetics and nutrition. Enterprises: choice, management and their interactions - Integrated farming system models for different agro eco-systems - Input management under IFS. Resource management under constraint situation - resource recycling in crop and enterprises – environmental impact on/of farming systems - farming system a way to sustainable agriculture.

Suggested readings

1. Devasenapathy, P.T.Ramesh and B.Gangwar 2007.Efficiency indices for agriculture management Research. New India Publishing Agency, New Delhi.
2. Jayanthi, C. Devasenapathy,P and C.Vennila. 2007. Farming Principles and Practices, Satish Serial Publishing House, New Delhi.
3. Panda, S.C. 2003. Cropping and Farming Systems. Agrobios Publishers. Jodhpur.
4. Palaniappan, SP and K. Sivaraman.1996. Cropping systems in the tropics Principles and management. New Age International (P) Ltd., New Delhi
5. Rangasamy, A., K. Annadurai, P.Subbian and C. Jayanthi. 2002. Farming System in the Tropics. Kalyani Publishers, Ludhiana.
6. Tandon, H.L.S. Recycling of Crop, Animal, Human and Industrial waste in Agriculture. FDCO Publishers, New Delhi.

Web readings

- www.pdfsr.ernet.in
- www.fao.org/ag/ca
- www.cimmyt.org/

21AG3244 ADVANCES IN CROP PRODUCTION AND SYSTEM MODELING

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. To familiarize about the recent concepts in crop production and systems approach.
2. Different management practices and their optimization.
3. Crop simulation models and advantages.

Course Outcomes:

On completion of this course, students will be able to

- 1.Summarize the system agriculture and holistic approaches.
- 2.Acquire knowledge on physiological factors limiting crop yields.
- 3.Gain knowledge on protected agriculture and its concepts.
- 4.Describe the methods of stress management in fruit crops.
- 5.Elucidate crop modeling, its scope and utility.
6. Calculating crop simulation models and advantages

Theory

System agriculture - holistic approach of systems - Physiological basis of variation in crop yield - role of biodiversity in sustainable food production - Sustainable agriculture: need, scope, practices and economic evaluation - Radiation energy - Importance - solar constant - Radiation laws - Radiation distribution in a

plant and in a plant community - Impacts of climate change on crop production - Photosynthesis - Photorespiration - Physiological factors limiting crop yields - microclimate and crop production - absorption of water in plants - Transpiration - definition and its importance - factors affecting water stress - consequences in physiological dimensions – Drought - Abiotic stresses (soil salinity, alkalinity, soil compaction and water logging etc.,) in crop production - Integrated input management and Integrated crop management practices in relation to global climate change - Crop water production function - Yield as function of different factors – recent advances in nutrient and water as inputs - Labour management - labour use efficiency - employment generation in intensive cropping system and farming system - Protected agriculture: concept, characteristics, types, scope and limitations in India- Global warming - Environmental concerns related to intensive use of agricultural inputs - GM crops - Crop diversification for improved food and nutritional security. Crop modeling: scope and utility - Systems classification - Flow charts, modeling techniques and methods of integration - State, rates and driving variables, feedbacks and relational diagrams. Elementary models for crop growth based on basic methods of growth analysis – crop simulation models and advantages - DSSAT, INFOCROP. Modeling for CO₂ assimilation, respiration, crop phenology, dry matter production and distribution, moisture availability and production - Levels of production – potential, attainable and actual – Modeling for moisture and nutrient limitations.

Suggested Readings

1. Gordan, G. 1992. *System Simulation*. 2nd Ed. Prentice Hall.
2. Kropff, M.J and Vann Laar HH. (Ed.). 1993. *Modelling Crop Weed Interactions*.
3. Mathews, R.B, Kropff, M.J., Bachelet, D and Vaan Laar, H.H. (Eds.). 1993. *Modelling the Impact of Climate Change on Rice Production in Asia*. CABI.
4. Penning de Vries, F.W.T and Van Laar, H.H. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.
5. Ritchie, J.T and Hanks, J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.
6. Zeigler, B.P. 1976. *Theory of Modeling and Simulation*. John Wiley and Sons.
7. Trivedi, P.C. 2010. Plant, Environment and Sustainability, Agrobios
8. Sunilkumar Brendra Prasad, Modern Technology for Sustainable Agriculture, NIPA, New Delhi.
9. A.R.Sharma/U.K.Behara, Resource Conserving Techniques in Crop Production, Scientific Publishers.
10. Rajesh, K. Vadav, Rajbir singh, Issues in Global Warming, Oxford, New Delhi.
11. Vijay Mittal, Eco System and Global Warming, Oxford, New Delhi

21AG3245 ADVANCES IN SOIL FERTILITY AND CROP MANAGEMENT

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. Soil fertility and sustainable agriculture.
2. Various composting technologies.
3. Integrated nutrient management and advantages.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concepts of soil fertility and productivity.
2. Describe various land capability classifications.
3. Discuss on the soil health parameters.
4. Apply knowledge on various composting technologies.
5. Overview on nutrient use efficiency.
6. Enumerate integrated nutrient management technologies.

Theory

Soil fertility in relation to sustainable agriculture - Concepts of soil fertility - Principles and Methods of soil test crop response studies - Response functions - Models - Land Capability Classification - Fertility Capability Classification - Transformation and Dynamics of nutrients in soil - Softwares and models in soil fertility management - Customized fertilizer recommendation. Soil health - Definition - Soil Quality - Indices: Physical, Chemical and Biological - Nutrient Cycling - Agronomic measures to improve soil health - Conservation Agriculture. Tools and techniques to build soil health - Soil health card - Organic matter –

Recycling - Composting - Vermicomposting - Fortified organic manures – Fertilizer management in open and controlled conditions - Quality standards - Soil organic carbon - Conservation and sequestration - Soil carbon pools under different land use systems - Scope of land use management on carbon trading. Biological methods of improving nutrient use efficiency - Biological nitrogen fixation - Biofertilizers - Microbial inoculants - P, K, Si, Zn solubilizers - Green and Green Leaf manures. Crops and Cropping Systems - Integrated Nutrient Management – INM for different agro ecosystems: Dry land, Garden land and Wet land - Organic farming and soil health - Ecological impact of fertilizer management - Problem soils and their management.

Suggested Readings

1. Cooke, G.W. 1986. Fertilizing for Maximum Yield Macmillan Publishing Company, New York
2. Kanwar, J.S. 1976. Soil Fertility – Theory and Practice, ICAR, New Delhi
3. Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrients. International Potash Institute, Bern, Switzerland.
4. Reading and Taylor, H.M. 1989. Principles of Soil Plant Relationship. McGraw-Hill, New York.
5. Russel, E.J. 2001. Soil Conditions and Plant Growth. Academic Press Inc. New York.
6. Singh, K.N., Kumar A.R and Sharma, D.K. 1998. Management of Problem Soils. In : Yadav, R.L., Singh. P., Prasad, R and Ahalawat, I.P.S. (ed.) Fifty Years of Agronomic Research in India. Indian Society of Agronomy, New Delhi.
7. Stevenson, F.J. 1985. Cycles of Soil Carbon, Nitrogen, Phosphorus, Sulphur and Micronutrients. Wiley – Interscience Publication, New York.
8. Tisdale, S.L., Nelson, W.L., Beaton, J.D and Havlin, J.L. 1995. Soil Fertility and Fertilizers, Mcmillan Publishing Company, New York.
9. Charles A.Black. 1993. Soil fertility evaluation and control. CRC Press.

Web readings

- www.uoa.edu.er/academics/graduate/.../courses.html
- www.fao.org/wairdocs/ilri/x5546e/x5546e08.htm
- www.fao.org/wairdocs/ilri/x5546e/x5546e08.htm
- www.uoa.edu.er/academics/graduate/.../courses.html
- www.energy.ca.gov/process/agriculture/ag_pubs/fertigation.pdf
- www.soilandhealth.org/.../010117attra/manual/010117attra.html
- <http://www.keralasoilfertility.net/>
- http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm

21AG3246 GENOMICS ASSISTED BREEDING IN CROPS

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Advances in Genetics and Genomics
2. Dissection of key genes and proteins
3. Integrating Genome to phenotype

Course Outcomes:

On completion of this course, students will be able to

1. Understand the molecular description of nuclear and organellar genomes
2. Analyze the mechanism of genetic control over gene expression and regulation in plants
3. Develop trait associated markers and primers for molecular breeding
4. Incorporate the knowledge in sequencing techniques across generations
5. Analyze the strategies for TILLING and ECO-TILLING
6. Understand the bioinformatics tools, databases in advanced genomics

Theory

Plant genome concepts and historical perspectives- Study of plant nuclear genomes and their molecular description – The role of chloroplast and the mitochondrial genomes in the functioning of plants - Genome size and complexity, C value paradox. Comparative genomics, Genome Comparison Techniques- Classical and advanced approaches. Fluorescence *in situ* hybridization (FISH), Genome *in situ* hybridization (GISH) -Comparative genomic hybridization –Genetic map construction using molecular markers in softwares – Mapping major genes and QTL's using molecular markers and Association studies. Developing molecular markers, primers and their validation. Approaches for mapping quantitative trait loci, Advanced

mapping populations implied in molecular breeding, association studies and Map based cloning of plant genes.

Plant genome mapping and sequencing projects - Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants and their case studies

Detection of Single Nucleotide Polymorphism; TILLING and Eco- TILLING. Role of transcriptomics, proteomics, Ionomics and metabolomics in linking genome and phenome; System Biology. Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping. Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics. Plant genome and protein databases, Regulation of Plant gene expression - Functional genomics - Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology. Advanced genomic approaches- Genomic selection, breeding by design, gene editing and Epigenetics.

Suggested Reading:

1. Baxevanis, A.D and Ouellette, B.F.F. (2001). *Bioinformatics A Practical Guide to the Analysis of Genes and Proteins*. Wiley and Sons.
2. Brown, T.A. (2002). *Genomes*. Wiley-LISS.
3. Caetano-Anolles, G and Gresshoff, P.M. (1998). *DNA Markers Protocols, Applications and Overviews*. Wiley-VCH.
4. Cantor, C.R and Smith, C.L. (2004). *Genomics*. Wiley and Sons, New York.
5. Galas, D.J and McCormack, S.J. (2002). *Genomic Technologies Present and Future*. Calster Academic Press.
6. Jordan, B.R. (2001). *DNA Microarrays Gene Expression Applications*. Springer Verlag.
7. Liu, B.H. (1997). *Statistical Genomics Linkage, Mapping and QTL Analysis*. CRS Press.
8. Lynch, M and Walsh, B. (1998). *Genetics and Analysis of Quantitative Traits*. Sinauer Associates.
9. Mount, D.W. (2001). *Bioinformatics. Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
10. Palzkill, T. (2002). *Proteomics*. Kluwer Publicationss.
11. Paterson, A.H. (1996). *Genome Mapping in Plants*. Academic Press.
12. Pennington, S.R and Dunn, M.J. (2002). *Proteomics from Protein Sequence to Function*. Viva Books.
13. Rampal, J.B. (2001). *DNA Arrays Methods and Protocols*. Humana Press.

21AG3247 CYTOGENETICS AND CHROMOSOME MANIPULATION IN CROPS

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Cellular structures and chromosome
2. Chromosome manipulations in crop improvement
3. Regulation of genes and its expression

Course Outcomes:

On completion of this course, students will be able to

1. Understand the organization of organellar and nuclear genomes
2. Remember the karyotyping procedures
3. Apply cytological techniques for crop improvement
4. Evaluate the breeding behavior in aneuploidy
5. Apply different micro propagation techniques
6. Explore various hybridization protocols and polyploidy for crop breeding

Theory

Role of Cellular organelles and their evolution in crops, Structure of Chromosome and its importance, Telomere and its role in functional regulation. Nuclear DNA organization – Nuclear and Cytoplasmic genome interactions and signal transduction; Process of Transcription and Translation. Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content –Introns and Exons-Genetic Regulators-Transcription factors – Repetitive sequences – Role of repetitive sequence. Role of RNA's and micro-RNA's. Transposons, its types and its role in crop improvement.

Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of genes/genomic segments; Distant hybridization - Role of polyploidy in crop evolution and breeding - auto and allopolyploids. Production of Haploids, Haploid inducers and double haploid technique.

Applications of cytogenetically methods for crop improvement; Location and mapping of genes on chromosomes deficiency method; Interchange- genetic consequence, identification of chromosomes involved and genelocation; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes- linked marker methods; Duplication - production and use; Inversions and location of genes; B/A chromosome translocations and gene location.

Chromosomal aberrations- Numerical and structural, Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics- methods of production, breeding behavior and location of genes; Inter varietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping. Barriers to interspecific and intergeneric hybridization- Behavior of interspecific and intergeneric crosses; Totipotency of cells – Morphogenesis *in vivo* and *in vitro* – Meristem culture – anther and pollen culture – ovule, ovary, embryo and endosperm culture – protoplast isolation and culture – protoplast fusion, Different pathways of *in vitro* morphogenesis – organogenesis and somatic embryogenesis; *in vitro* mutant/somaclone selection for biotic and abiotic stresses.

Suggested Reading:

1. Clark, M.S and Wall, W.J. (1996). *Chromosomes The Complex Code*. Chapman and Hall.
2. Conger, B.V. (1981). *Cloning Agricultural Plants via in vitro Techniques*. CRC Press.
3. Constabel, F and Vasil, I.K. ((1988). *Cell Culture and Somatic Cell Genetics of Plants*. Vol. V. *Cell Culture and Phytochemicals in Plant Cell Cultures*. Academic Press.
4. Lal, R and Lal, S. (1990). *Crop Improvement Utilizing Biotechnology*. CRC Press.
5. Mantel, S.H and Smith, H. (1983). *Plant Biotechnology*. Cambridge University Press.
6. Sen, S.K and Giles, K.L. (1983). *Plant Cell Culture in Crop Improvement*. Plenum Press.

21AG3248 ADVANCED PLANT BREEDING SYSTEMS

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Principles of Breeding and mating systems
2. Cytonuclear interactions and their manipulation
3. Advanced Selection techniques and population improvement

Course Outcomes:

On completion of this course, students will be able to

1. Understand the evolutionary concepts of plant breeding
2. Apply the principles of plant breeding in developing breeding populations
3. Synthesize Mendelian and complex populations
4. Understand the selection principles for self- and cross-pollinated crops
5. Analyze different genetic engineering methods for developing male sterile populations
6. Generate new cyto-nuclear systems to diversify the male sterile systems

Theory

Mendelian Breeding Concepts-Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination. Self- incompatibility and sterility – Types of Self-Incompatibility Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility. Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self-incompatibility; Sterility male and female sterility – Types of male sterility Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic, biochemical and molecular bases. Apomixis and its use in heterosis breeding - Incongruity - Factors influencing incongruity - Methods to overcome incongruity mechanisms. Types of populations - Mendelian population, gene pool, composites, synthetics etc.; Genetic basis of population improvement. Selection in self-fertilizing crops; Creation of genetic variability selection methods - Selection methods mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross. Selection in cross fertilizing crops – Polycross and top cross selections, Mass and recurrent selection methods and their modifications - Mass selection grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection

Simple recurrent selection and its modifications Selection in clonally propagated crops – Assumptions and realities.

Genetic engineering technologies to create male sterility; Prospects and problems - Fertility restoration in male sterile lines and restorer diversification Programs. Conversion of agronomically ideal genotypes into male sterile. Generating new cytonuclear interaction system for diversification of male sterile lines - Stability of male sterile lines – Environmental influence on sterility–Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding.

Suggested Reading:

1. Agarwal, R.L. (1996). *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford and IBH.
2. Allard, R.W. (1966). *Principles of Plant Breeding*. John Wiley and Sons.
3. Briggs, F.N and Knowles, P.F. (1967). *Introduction to Plant Breeding*. John Wiley and Sons.
4. Reinhold Fehr, W.R. (1987). *Principles of Cultivar Development Theory and Technique*. Vol I. Macmillan.
5. Hayes, H.K., Immer, F.R and Smith, D.C. (1955). *Methods of Plant Breeding*. McGraw-Hill.
6. Mandal, A.K., Ganguli, P.K and Banerji, S.P. (1995). *Advances in Plant Breeding*. Vol. I, II. CBS.
7. Richards, A.J. (1986). *Plant Breeding Systems*. George Allen and Unwin.
8. Sharma, J.R. (1994). *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
9. Simmonds, N.W. (1979). *Principles of Crop Improvement*. Longman.
10. Singh, B.D. (1997). *Plant Breeding Principles and Methods*. 5th Ed., Kalyani Publishers.
11. Singh, P. (1996). *Essentials of Plant Breeding*. Kalyani Publishers.
12. Welsh, J.R. (1981). *Fundamentals of Plant Genetic and Breeding*. John Wiley.
13. Williams, W. (1964). *Genetical Principles and Plant Breeding*. Blackwell.

21AG3249 BIOMETRICAL TECHNIQUES IN CROP IMPROVEMENT

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Theoretical and computation skills for estimating the components of variation
2. Evaluating the mating designs in plant breeding
3. Interpreting the gene action, scales and gene effects

Course Outcomes:

On completion of this course, students will be able to

1. Identify suitable breeding procedures for trait specific improvement
2. Interpret the gene actions and selection indices for suitable parents
3. Compute the designs of experiments involved in breeding programs
4. Interpret the results effected in mating designs and analyze their statistical parameters
5. Generate mapping populations for QTL analysis and marker assisted selection
6. Identify the marker-trait association and QTL's in a population

Theory

Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Working out efficiency of selection methods in different populations and interpretation - Biparental mating – use of softwares in analysis and result interpretation - Trialallel analysis– use of softwares in analysis and result interpretation - Quadriallel analysis – use of softwares in analysis and result interpretation - Triple Test Cross (TTC) – use of softwares in analysis and result interpretation - Advanced biometrical models for combining ability analysis–Use of Multiple regression analysis in selection of genotypes; Designs and Systems; Selection of stable genotypes. Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Selection of stable genotypes using stability analysis; Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model - Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model-Principal Component Analysis. Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes. - Selection systems - Biplots and mapping genotypes. Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance - Construction of saturated linkage maps, concept of framework map development; QTL mapping- Strategies for QTL mapping - desired populations, statistical methods; Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Suggested Reading:

1. Bos, I and Caligari, P. (1995). *Selection Methods in Plant Breeding*. Chapman and Hall.
2. Falconer, D.S and Mackay, J. (1996). *Introduction to Quantitative Genetics*. Longman.
3. Mather, K and Jinks, L. (1983). *Introduction to Biometrical Genetics*. Chapman and Hall.
4. Nadarajan, N and Gunasekaran, M. (2005). *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani Publishers.
5. Singh, P and Narayanan, S.S. (1993). *Biometrical Techniques in Plant Breeding*. Kalyani Publishers.
6. Singh, R.K and Choudhary, B.D. (1987). *Biometrical Methods in Quantitative Genetics*. Kalyani Publishers.
7. Weir, D.S. (1990). *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.
8. Wricke, G and Weber, W.E. (1986). *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

21AG3250. PLANT GENETIC RESOURCES AND ITS IMPORTANCE

Credits: 2(2+0)

Course objectives:

To impart knowledge on

1. Concepts of plant exploration and collection
2. Conservation practices of germplasm accessions
3. Quarantine procedures for introduced collections

Course Outcomes:

On Completion of this course, students will be able to

1. Locate the micro and mega gene centers of crop plants
2. Understand the diversity hotspots concepts
3. Apply the procedures in germplasm exchange formalities
4. Realize the importance for plant quarantine certificates
5. Recognize the plant introductions which turned into weeds
6. Analyze the intellectual property rights and their regulations

Theory

Importance of PGR conservation; Taxonomical classification of cultivated plants; Gene pool primary, secondary and tertiary; Centers of origin and global pattern of diversity; Evolution of Major Food Crops, Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Gene Bank and its types-Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.

Germplasm conservation- *in situ*, *ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetative propagated crops; Registration of plant genetic resources. PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; IUCN and CBD conventions-PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.

Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre-Mendelian era and 21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

Distant Hybridization Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression. Post-genomic tools for genetic enhancement of germplasm; Pre-breeding through chromosome manipulation; Application of biotechnology for Genetic Enhancement-

Achievements. Utilization of genetic resources, concept of core and mini-core collections, genetic enhancement /Pre-breeding for crop improvement including hybrid development.

Suggested Reading:

1. Frankel, O.H and Bennett, E. (1970). *Genetic Resources in Plants – their Exploration and Conservation*. Blackwell Publications.
2. Gautam, P.L., Dass, B.S., Srivastava, U and Duhoon, S.S. (1998). *Plant Germplasm Collecting Principles and Procedures*. NBPGR, New Delhi.
3. Painting, K.A., Perry, M.C., Denning, R.A and Ayad, W.G. (1993). *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.
4. Paroda, R.S and Arora, R.K. (1991). *Plant Genetic Resources, Conservation and Management. Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.
5. Puzone, L and Hazekamp, T.H. (1996). *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.
6. Rana, R.S., Sapra, R.L., Agrawal, R.C and Gambhir, R. (1991). *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.
7. Singh, R.J and Jauhar, P.P. (2005). *Genetic Resources, Chromosomal Engineering and Crop Improvement*. Vol. I. *Grain Legumes*, Vol. II. *Cereals*. CRC Press, Taylor and Francis Group, USA.

21AG3251 BREEDING FOR STRESS AND QUALITY TRAITS

Credits: 2(2+0)

Course objectives:

To impart knowledge on

1. Climate Resilient Varieties and hybrids
2. Utilization of Wild relatives
3. Biofortification of Food crops

Course Outcomes:

On Completion of this course, students will be able to

1. Identify and Screen the tolerant and susceptible lines
2. Understand the kinds of stresses and its impact in plant growth
3. Realize the importance of nutrition in food and its enhancement by breeding
4. Evaluate the novel breeding techniques for stress tolerance in plants
5. Recognize the role of molecular tools in stress and quality breeding
6. Analyze the antinutritional factors in crops

Theory

Classification of Stress- Abiotic & Biotic types its effect on plants. Metabolisms affecting the plant systems due to various kinds of stresses, signaling pathways, Identified Genes and their role in tolerating the effect of stress in crops. Major abiotic stress -Drought, Chilling, Heat, salinity, alkalinity, sodicity and mineral toxicity- Breeding methods for abiotic stress tolerance, Molecular markers in abiotic stress breeding-success stories and Case studies. Exploitation of Wild relatives in imparting stress tolerance in plants-Screening Techniques for Abiotic stresses and identification of tolerant lines. Role of Proteomics, metabolomics and transcriptomics in abiotic stress tolerance of plants.

Concepts in insect and Pathogen Resistance- Analysis and Inheritance of Resistance-virulence-avirulence, Horizontal and Vertical Resistance in Crops-Biochemical and Molecular mechanisms-Defense responses for invasion of pathogens and insects-Acquired and Induced Immunity-Systemic Acquired Resistance-Measuring Plant Resistance using plant fitness- Behavioural, physiological and insect gain studies-Screening methods and Scoring for Resistance-Host Plant Resistance- Major Pests and Diseases affecting crops-Identified Genes their role-Utilization of Markers, Transgenes and Case studies. Metabolic Pathways involved in Pathogen and Pest infestations, Gene Silencing, Breeding methods for resistance against viral infections -Gene silencing, Gene editing.

Breeding for special traits viz. oil, protein, vitamins, amino acids and micronutrients. Anti-nutritional factors in food crops and its manipulation in crops to enhance Nutrient uptake. Role of International and National Institutes for biofortification. Breeding methods for enhancing Quality-effect on yield parameters-Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming. Biosafety management, segregation and isolation requirements in designercrop production and post-harvest management

Suggested Reading

1. Singh, B. D. (2006). *Plant Breeding - Principles and Methods*. Kalyani Publishers. Singh, P and Singh, S. (1998). *Heterosis Breeding in Cotton*. Kalyani Publishers.
2. Singh, S and Singh, P. 2006. *Trends in Wheat Breeding*. Kalyani Publishers.
3. Pessarakli, M. (1995). *Handbook of Plant and Crop Physiology*. Marcel Dekker.
4. Taiz, L and Zeiger, E. (2006). *Plant Physiology*. 4th Ed. Sinauer Associates.
5. Panda, N. (1979). *Principles of Host Plant Resistance to Insects*. Allenheld, Osum & Co., New York.
6. Rosenthal, G.A and Janzen, D.H. (Eds.). (1979). *Herbivores – their Interactions with Secondary Plant Metabolites*. Vol. I, II. Academic Press, New York.

21AG3252 ADVANCED INSECT TAXONOMY

Credits: 3 (3+0)

Course Objectives:

To impart knowledge on

1. Insect classification, phylogenetics, classical and molecular methods
2. Evolution of different groups of insects and International Code of Zoological Nomenclature
3. Ethics and procedure for taxonomic publications

Course Outcomes:

On completion of this course, students will be able to

1. Understanding and learning about insect classification, evolutionary history and cladistics
2. Familiarize with the International Code of Zoological Nomenclature, including appendices to ICZN- Ethics
3. Acquire knowledge on the evolution of insects
4. Understand the concept of phylocode
5. Gain Knowledge on alternative naming systems for insects
6. Acquire knowledge on molecular taxonomy and barcoding species

Theory

Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography.

Study of different views on the evolution of insects- alternative phylogenies of insects Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times. Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics. Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic Publications – small Publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species. Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer Programs to develop cladograms.

Suggested Reading:

1. CSIRO (1990). *The Insects of Australia A Text Book for Students and Researchers*. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.
2. Dakeshott, J and Whitten, M. A. (1994). *Molecular Approaches to Fundamental and Applied Entomology*. Springer-Verlag, Berlin.
3. Freeman, S and Herron, J.C. (1998). *Evolutionary Analysis*. Prentice Hall, New Delhi.
4. Hennig, W. (1960). *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.
5. Hoy, M.A. (2003). *Insect Molecular Genetics An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.
6. Mayr, E and Ashlock, P.D. (1991). *Principles of Systematic Zoology*. 2nd Ed. McGraw Hill, New York.
7. Mayr, E. (1969). *Principles of Systematic Zoology*. McGraw-Hill, New York.
8. Quicke, D.L.J. (1993). *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic and Professional, London.
9. Ross, H.H. (1974). *Biological Systematics*. Addison Wesley Publ. Co., London.

10. Wiley, E.O. (1981). *Phylogenetics The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press, USA.

21AG3253 INSECT TOXICOLOGY

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Latest advancements in the field of insecticide toxicology
2. Biochemical and physiological target sites of insecticides
3. Pesticide resistance mechanisms in insects

Course Outcomes:

On completion of this course, students will be able to

1. Understand the penetration and distribution of insecticides in insect systems
2. Identify the problems associated with pesticide residues in agriculture ecosystem
3. Understand the biochemical and physiological target sites of insecticides in insects
4. Learn about insecticide laws and standards, and good agricultural practices
5. Gain knowledge on biochemical and biological techniques for detection of insecticide resistance in insects
6. Acquire and adopt different advanced methods for estimation of insecticide residues

Theory

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides. Joint action of insecticides; activation, synergism and potentiation.

Problems associated with pesticide use in agriculture pesticide resistance- resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects. Biochemical and biological techniques for detection of insecticide resistance in insects.

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

Suggested Reading:

1. Busvine, J.R. (1971). *A Critical Review on the Techniques for Testing Insecticides*. CABI, London.
2. Dhaliwal, G.S and Koul, O. (2007). *Biopesticides and Pest Management*. Kalyani Publications New Delhi.
3. Hayes, W.J and Laws, E.R. (1991). *Handbook of Pesticide Toxicology*. Academic Press, New York.
4. Ishaaya, I and Degheele (Eds.). (1998). *Insecticides with Novel Modes of Action*. Narosa Publications, House, New Delhi.
5. Matsumura, F. (1985). *Toxicology of Insecticides*. Plenum Press, New York.
6. O' Brien, R.D. (1974). *Insecticides Action and Metabolism*. Academic Press, New York.
7. Perry, A.S, Yamamoto, I., Ishaaya, I. and Perry, R. (1998). *Insecticides in Agriculture and Environment*. Narosa Publ. House, New Delhi.
8. Prakash, A and Rao, J. (1997). *Botanical Pesticides in Agriculture*. Lewis Publications New York.

21AG3254 HOST PLANT RESISTANCE

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Recent advances in resistance of plants to insects
2. Techniques for assessment and evaluation of resistance in crop plants
3. Biotechnological approaches in host plant resistance

Course Outcomes:

On completion of this course, students will be able to

1. Acquire knowledge on techniques and determination of categories of plant resistance
2. Understand the importance of plant resistance
3. Learn about physical and chemical environment conferring resistance in plants

4. Understanding mechanisms of resistance for orientation, feeding, oviposition etc.,
5. Identify the plant resistance based on genotype expression
6. Apply the advanced biotechnological tools in host plant resistance

Theory

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors. Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding. Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Suggested Reading:

1. Panda, N. (1979). *Principles of Host Plant Resistance to Insects*. Allenheld, Osum & Co., New York.
2. Rosenthal, G.A and Janzen, D.H. (Eds.). (1979). *Herbivores – their Interactions with Secondary Plant Metabolites*. Vol. I, II. Academic Press, New York.
3. Sadasivam, S and Thayumanavan, B. (2003). *Molecular Host Plant Resistance to Pests*. Marcel Dekker, New York.
- Smith, C.M., Khan, Z.R and Pathak, M.D. (1994). *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida.

21AG3255 BIOTECHNOLOGICAL APPROACHES IN ENTOMOLOGICAL RESEARCH

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. Molecular techniques in entomological research
2. Biotechnological approaches in sericulture and apiculture
3. Genes of interest in entomological research

Course Outcomes:

On completion of this course, students will be able to

1. Understand the techniques used in molecular biology
2. Learn about the DNA and RNA analysis in insects
3. Understand the DNA recombinant technology and identification of genes for characters of interest
4. Gain knowledge on the genetic improvement of natural enemies
5. Acquire knowledge on insect gene transformation in relation to silkworms and honey bees
6. Develop a resistance management strategy in transgenic crops

Theory

Introduction to molecular biology; techniques used in molecular biology. DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, Bt and entomopathogenic fungi. Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, neuropeptides. Transgenic plants for pest resistance and diseases.

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies. DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

Suggested Reading:

1. Bhattacharya, T.K., Kumar, P and Sharma, A. (2007). *Animal Biotechnology*. 1st Ed., Kalyani Publications New Delhi.

2. Hagedon, H.H., Hilderbrand, J.G., Kidwell, M.G. and Law, J.H. (1990). *Molecular Insect Science*. Plenum Press, New York.
3. Oakeshott, J and Whitten, M.A. (1994). *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.
4. Rechcigl J.E and Rechcigl N.A. (1998). *Biological and Biotechnological Control of Insect Pests*. Lewis Publications North Carolina.
5. Roy, U and Saxena, V. (2007). *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publications New Delhi.
6. Singh, B.D. (2008). *Biotechnology (Expanding Horizons)*. Kalyani Publications New Delhi.
7. Singh, P. (2007). *Introductory to Biotechnology*. 2nd Ed. Kalyani Publications New Delhi.

21AG3256 INTEGRATED INSECT PEST MANAGEMENT

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Recent problems with alien pest and use of IPM
2. Surveillance and data base management as a tool in IPM
3. Successful national and international case histories of integrated pest management

Course Outcomes:

On completion of this course, students will be able to

1. Understand the principles and concepts of IPM
2. Acquire knowledge on data base management, simulation techniques and system analysis
3. Assess the new technologies in genetic engineering and their progress and limitations in IPM Programs
4. Acquire and adopt different strategies in pesticide resistance management.
5. Familiarize with new technologies and their progress and limitations in IPM Programs
6. Understand the scope and limitations of bio-intensive and ecological based IPM Programs

Theory

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modelling. Case histories of national and international Programs, their implementation, adoption and criticisms, global trade and risk of invasive pests.

Genetic engineering and new technologies- their progress and limitations in IPM Programs, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM Programs. Application of IPM to farmers' real time situations.

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Suggested Reading:

1. Dhaliwal, G.S and Arora, R. (2003). *Integrated Pest Management – Concepts and Approaches*. Kalyani Publications, New Delhi.
2. Dhaliwal, G.S, Singh, R and Chhillar, B.S. (2006). *Essentials of Agricultural Entomology*. Kalyani Publications, New Delhi.
3. Flint, M.C and Bosch, R.V. (1981). *Introduction to Integrated Pest Management*. Springer, Berlin.
4. Koul, O and Cuperus, G.W. (2007). *Ecologically Based Integrated Pest Management*. CABI, London.
5. Koul, O., Dhaliwal, G.S and Curperus, G.W. (2004). *Integrated Pest Management -Potential, Constraints and Challenges*. CABI, London.
6. Maredia, K.M., Dakouo, D and Mota-Sanchez, D. (2003). *Integrated Pest Management in the Global Arena*. CABI, London.
7. Metcalf, R.L and Luckman, W.H. (1982). *Introduction of Insect Pest Management*. John Wiley & Sons, New York.
8. Norris, R.F., Caswell-Chen, E.P and Kogan, M. (2002). *Concept in Integrated Pest Management*. Prentice Hall, New Delhi.
9. Pedigo, R.L. (1996). *Entomology and Pest Management*. Prentice Hall, New Delhi.
10. Subramanyam, B and Hagstrum, D.W. (1995). *Integrated Management of Insects in Stored Products*. Marcel Dekker, New York.

21AG3257 BIOLOGICAL CONTROL OF INSECT PESTS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Role of biocontrol agents in pest management
2. Advanced techniques for mass multiplication and field release of biocontrol agents
3. Scope of biocontrol agents in organic farming system

Course Outcomes:

On completion of this course, students will be able to

1. Understand the scope of classical biological control and augmentative biocontrol
2. Identify the dynamics of biocontrol agents against target pest populations
3. Understand the mass culturing techniques of biocontrol agents
4. Identify the scope of genetically engineered microbes and parasitoids in biological control
5. Develop a holistic knowledge on large-scale production of biocontrol agents
6. Apply the knowledge for overcoming insecticide resistance pest population using biocontrol agents

Theory

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents vis-à-vis target pest populations. Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation. Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Suggested Reading:

1. Burges, H.D and Hussey, N.W. (Eds.). (1971). *Microbial Control of Insects and Mites*. Academic Press, London.
2. Coppel, H.C and James, W.M. (1977). *Biological Insect Pest Suppression*. Springer Verlag, Berlin.
3. De Bach, P. (1964). *Biological Control of Insect Pests and Weeds*. Chapman & Hall, London.
4. Dhaliwal, G.S and Koul, O. (2007). *Biopesticides and Pest Management*. Kalyani Publications, New Delhi.
5. Gerson, H and Smiley, R.L. (1990). *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.
6. Huffaker, C.B and Messenger, P.S. (1976). *Theory and Practices of Biological Control*. Academic Press, London.

21AG3258 ADVANCED MYCOLOGY

Credits: 3 (3+0)

Course Objectives:

To impart knowledge on

4. Advances in Fungi and their structures
5. Molecular methods of classification of fungi
6. Revealing way of pathogen invasion and management

Course Outcomes:

On completion of this course, students will be able to

1. Understand the method of invasion of pathogens
2. Remember the molecular characterization and taxonomy classification
3. Apply these techniques for management of fungicidal resistant fungi
4. Evaluate the characters of fungi
5. Explore the different phylogeny characters of fungi
6. Advanced criteria for management of disease

Theory

General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy. Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfect. Morphology and reproduction of

representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi. Population biology, pathogenic variability/vegetative compatibility.

Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. biodegradation.

Suggested Readings

1. Alexopoulos CJ, Mimms CW & Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York.
2. Dube HC. 2005. *An Introduction to Fungi*. 3rd Ed. Vikas Publ. House, New Delhi.
3. Kirk PM, Cannon PF, David JC & Stalpers JA. (Eds.). 2001. *Ainsworth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington. 258.
4. Ulloa M & Hanlin RT. 2000. *Illustrated Dictionary of Mycology*. APS, St. Paul, Minnesota.
5. Webster J & Weber R. 2007. *Introduction to Fungi*. Cambridge Univ. Press, Cambridge.

21AG3259 ADVANCED VIROLOGY

Credits: 3 (3+0)

Course Objectives:

To impart knowledge on

1. Principles of virus infection
2. Antibody production technology
3. Genome organization, replication, transcription and translational strategies

Course Outcomes:

On completion of this course, students will be able to

1. Understand the virus infection and replication
2. Apply the knowledge on development virus resistant varieties
3. Analyse the virus-vector relationship
4. Advanced method of studying structures and characters of virus
5. Molecular tools for identification of pathogenic viruses
6. Genetic engineering with plant viruses, viral suppressors, an RNAi dynamics, resistant genes.

Theory

Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultra structural changes due to virus infection, variation, mutation and virus strains. Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.

Genome organization, replication, transcription and translational strategies of pararetro viruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucummo, ilar and tospoviruses. Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions. Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture. Origin, evolution and inter relationship with animal viruses.

Suggested Readings

1. Davies 1997. *Molecular Plant Virology: Replication and Gene Expression*. CRC Press, Florida
2. Fauquet *et al.* 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press, New York.
3. Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.
4. Jones P, Jones PG & Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques*. John Wiley & Sons, New York. 83
5. Khan JA & Dijkstra. 2002. *Plant Viruses as Molecular Pathogens*.
6. Howarth Press, New York. Maramorosch K, Murphy FA & Shatkin AJ. 1996. *Advances in Virus Research*. Vol. 46. Academic Press, New York.
7. Pirone TP & Shaw JG. 1990. *Viral Genes and Plant Pathogenesis*. Springer Verlag, New York.
8. Roger Hull 2002. *Mathew's Plant Virology* (4th Ed.). Academic Press, New York.
9. Thresh JM. 2006. *Plant Virus Epidemiology*. Advances in Virus Research 67. Academic Press, New York.

21AG3260 ADVANCED BACTERIOLOGY

Credits: 3 (3+0)

Course Objectives:

To impart knowledge on

1. To provide knowledge about the latest advances in phytobacteriology
2. Study on secretion systems of bacteria
3. Identification of phytopathogenic bacteria

Course Outcomes:

On completion of this course, students will be able to

1. Understand the Host-bacterial pathogen interaction
2. Remember the factor responsible for spreading disease
3. Apply knowledge on molecular characterization of phytopathogenic bacteria
4. Development of diagnostic kit
5. Evaluate the beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management
6. Analyse the mechanism of disease development

Theory

Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria. Current trends in taxonomy of phytopathogenic procarya. Role of enzyme, toxin, exopolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumefaciens*).

Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein. Molecular variability among phytopathogenic procarya and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens-gene silencing, RNAi technology. Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit. Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Suggested Readings

1. Dale JW & Simon P. 2004. *Molecular Genetics of Bacteria*. John Wiley & Sons, New York.84.
2. Garrity GM, Krieg NR & Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria*. Vol. II. Springer Verlag, New York.
3. Gnanamanickam SS. 2006. *Plant-Associated Bacteria*. Springer Verlag, New York.
4. Mount MS & Lacy GH. 1982. *Plant Pathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.
5. Sigeo DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects*. Cambridge Univ. Press, Cambridge.
6. Starr MP. 1992. *The Prokaryotes*. Vols. I-IV. Springer Verlag, New York.

21AG3261 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. Advanced techniques in Molecular Plant Pathology
2. To understand the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.
3. Genetic engineering approach for management of plant disease

Course Outcomes:

On completion of this course, students will be able to

1. Understand the mechanism of host-pathogen interactions.
2. Apply the knowledge on induced systemic resistance
3. Remember the methods of gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection
4. Evaluate the Biotechnology method of disease management
5. Analyze the gene-for-gene hypothesis R and Avr gene
6. Evaluate the pathogenesis related proteins for induction disease resistance

Theory

Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship. Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

Induction of defense responses- pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing. Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Suggested Readings

1. Chet I. 1993. *Biotechnology in Plant Disease Control*. John Wiley & Sons, New York.
2. Gurr SJ, McPohersen MJ & Bowlos DJ. (Eds.). 1992. *Molecular Plant Pathology - A Practical Approach*. Vols. I & II, Oxford Univ. Press, Oxford.
3. Mathew JD. 2003. *Molecular Plant Pathology*. Bios Scientific Publ., UK.
4. Ronald PC. 2007. *Plant-Pathogen Interactions: Methods in Molecular Biology*. Humana Press, New Jersey. 85.
5. Stacey G & Keen TN. (Eds.). 1996. *Plant Microbe Interactions*. Vols. III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

21AG3262 PLANT BIOSECURITY AND BIOSAFETY

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. Advances in plant biosecurity and biosafety
2. Plant quarantine regulations on pest and diseases
3. Integrated approaches on biosecurity and biosafety

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concept and components of biosecurity
2. Remember the national regulatory mechanism and international agreements
3. Apply these techniques for plant biosecurity, pest/disease and epidemic management
4. Evaluate the biosafety policies and regulatory mechanism
5. Explore the different pest risk analysis, assessment models and pest information system
6. Advanced criteria for issues related to release of genetically modified crops

Theory

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases. National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

1. FAO Biosecurity Toolkit 2008. www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory. Guidance.
2. Biosecurity http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006.pdf
3. Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan*. http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_plan.pdf *Biosecurity Australia*. www.daff.gov.au/ba; www.affa.gov.au/biosecurityaustralia *Biosecurity New Zealand*. www.biosecurity.govt.nz/DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm
4. Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns*. NBPGR, New Delhi.

5. Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India – Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-63.
6. Biosecurity for Agriculture and Food Production. <http://www.fao.org/biosecurity/CFIA>. <http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtml87>

21AG3263 PRINCIPLES AND PROCEDURES OF CERTIFICATION

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. Advanced techniques in the certification and quality control
2. National status of seed health in seed certification
3. Role of seed/ planting material health certification in national and international trade.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concept and procedures for seed certification
2. Remember the national regulatory mechanism and minimum seed certification standards
3. Apply these techniques in certification of seeds, vegetative propagules and *in vitro* cultures
4. Evaluate the methods used in certification of seeds, vegetative propagules and *in vitro* cultures
5. Explore the limits for diseases and insect pests in certification and quality control programmes
6. Advanced techniques for testing genetic identity, physical purity, germination percentage, seed health

Theory

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc.

Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and *in vitro* cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

Suggested Readings

1. Association of Official Seed Certifying Agencies. <http://www.aosca.org/index.htm>.
2. Hutchins D & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI, UK.
3. ISHI-veg Manual of Seed Health Testing Methods. http://www.worldseed.org/enus/international_seed/ishi_vegetable.html ISHI-F Manual of Seed Health Testing Methods. http://www.worldseed.org/en-us/international_seed/ishi_f.html ISTA Seed Health Testing Methods. <http://www.seedtest.org/en/content---1--1132--241.html>
4. Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System. <http://www.seedhealth.org/>

21HO3270 PRODUCTION TECHNOLOGY TRENDS IN FRUIT CROPS

Credits: 3 (3+0)

Course objectives:

To impart knowledge on

1. Recent techniques in production technology of fruit crops
2. Recent advances in the propagation of fruit crops
3. Recent trends in orchard management

Course Outcomes:

At the end of this course, the students will be able to

1. Explain the national and international scenario of fruit production
2. Demonstrate on the advanced propagation techniques of fruit crops
3. Discuss on the recent achievements in crop regulation
4. Elucidate on the advances in high density and ultra-high density planting systems and crop modelling

5. Explain on the modern approaches in water and nutrient management in fruit crops
6. Discuss the strategies to overcome biotic and abiotic stress effects

Theory

National and International scenario in fruit production, Survey of existing fruit cropping systems and development of a model cropping system, Recent advances in propagation – rootstock influence, planting systems, High density planting, crop modelling, Precision farming, decision support systems, Aspects of crop regulation- physical and chemical regulation effects on physiology and development, practices in plant growth regulation, Influence of stress factors, strategies to overcome stress effects, estimation of nutrient deficiency, estimation of water use efficiency, integrated and modern approaches in water and nutrient management, Total quality management (TQM), Current topics. Crops viz., Mango, banana, papaya, grapes, citrus, guava, sapota, pomegranate, aonla, pineapple, avocado, jack fruit, fig, apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Suggested Reading

1. Bose, T. K., Mitra, S. K. and Rathore, D.S. (Eds.). (1988). *Temperate fruits –Horticulture*. Allied Publ.
2. Bose, T. K., Mitra, S. K. and Sanyal, D. (Eds.). (2001). *Fruits -Tropical and subtropical*. Naya Udyog.
3. Bose, T. K., Mitra, S. K., Farooqi, A. A. and Sadhu, M. K. (1999). *Tropical Horticulture*. Vol. I. Naya Prokash.
4. Chadha, K. L. and Pareek, O. P. (Eds.). (1996). *Advances in horticulture*. Vols. IIIIV. Malhotra Publishing House.
5. Chadha, K. L. (2001). *Handbook of horticulture*. ICAR.
6. Nakasone, H. Y. and Paull, R. E. (1998). *Tropical fruits*. CABI.
7. Radha, T. and Mathew, L. (2007). *Fruit crops*. New India Publ. Agency.

21HO3271 ADVANCES IN GROWTH PHYSIOLOGY OF FRUIT CROPS

Credits: 3 (3+0)

Course Objectives:

To impart basic knowledge on

1. The hormonal biosynthesis of growth regulators and inhibitors
2. Growth regulation aspects at various stages of fruit growth
3. Overview on the molecular approaches in crop growth regulation

Course Outcomes:

At the end of this course, the students will be able to

1. Describe the eco-physiological influences on growth and development of fruit crops
2. Explain on the biosynthesis of growth regulators and retardants
3. Enumerate on the physiology of plant at various stages of growth
4. Discuss on the root and canopy regulation of fruits
5. Elucidate on the canopy management for orchards
6. Overview on the molecular and genetic approaches in crop growth regulation

Theory

Eco-physiological influences on growth and development of fruit crops, flowering, fruit set, Crop load and assimilate partitioning and distribution, Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, Absorption, translocation and degradation of phyto-hormones, internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards. Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruit set and development, fruit drop, parthenocarp, fruit maturity and ripening and storage, molecular approaches in crop growth regulation, current topics.

Suggested Reading

1. Buchanan, B., Gruissam, W. and Jones, R. (2002). *Biochemistry and molecular biology of plants*. John Wiley & Sons.
2. Epstein, E. (1972). *Mineral nutrition of plants: Principles and Perspectives*. Wiley.

3. Fosket, D. E. (1994). *Plant growth and development: A Molecular Approach*. Academic Press.
4. Leopold, A. C. and Kriedemann, P. E. (1985). *Plant growth and development*. 3rdEd. McGraw-Hill.
5. Radha, T. and Mathew, L. (2007). *Fruit crops*. New India Publ. Agency.
6. Roberts, J., Downs, S. and Parker, P. (2002). Plant growth development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
7. Salisbury, F. B. and Ross, C.W. (1992). *Plant physiology*. 4th Ed. Wadsworth Publ.

21HO3272 FRUIT CROP IMPROVEMENT

Credits: 3 (3+0)

Course Objectives:

To impart basic knowledge on

1. Advanced methods in crop improvement of fruit crops
2. Breeding achievements in crop improvement of fruit crops
3. Recent trends in research of breeding tropical, subtropical and temperate fruit crops

Course Outcomes:

At the end of this course, the students will be able to

1. Outline the breeding objectives for fruit crops
2. Discuss the evolutionary pattern of fruit crops
3. Explain the incompatibility systems of fruit crops
4. Explain the recent advances in crop improvement of fruit crops
5. Describe the resistance breeding in biotic and abiotic stresses of fruit crops
6. Overview on the recent molecular and transgenic approaches in breeding of fruit crops

Theory

Evolutionary mechanisms, adaptation and domestication, genetic resources, cytogenetics, cyto morphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits, recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops. Description and cataloguing of germplasm, pollen viability tests, pollen germination- isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques. Crops viz., Mango, banana, papaya, grapes, citrus, guava, sapota, pineapple, avocado, apple, pear, plums, peaches, apricot, cherries and strawberry

Suggested Reading

1. Bose, T. K., Mitra, S. K. and Sanyal, D. (Ed.). (2002). *Fruits of India – Tropical and sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
2. Chadha, K. L. and Pareek, O. P. (Eds.). (1996). *Advances in horticulture*. Vol. I. Malhotra Publ. House.
3. Chadha, K. L. and Shikhamany, S. D. (1999). *The Grape: Improvement, production and Post-Harvest Management*. Malhotra Publ. House.
4. Gowen, S. (1996). *Banana and plantains*. Chapman & Hall.
5. Janick, J. and Moore, J. N. (1996). *Fruit breeding*. Vols. I-III. John Wiley & Sons.
6. Nijjar, G. S. (Ed.). (1977). *Fruit breeding in India*. Oxford & IBH.
7. Radha, T. and Mathew, L. (2007). *Fruit crops*. New India Publ. Agency.
8. Singh, S., Shivankar, V. J., Srivastava, A. K. and Singh, I. P. (Eds.). (2004). *Advances in citriculture*. Jagminder Book Agency.
9. Stover, R. H. and Simmonds, N. W. (1991). *Bananas*. Longman.

21HO3273 GENETIC RESOURCE INFORMATICS IN HORTICULTURE

Credits: 2 (2+0)

Course Objectives:

To impart basic knowledge on

1. Handling genomic databases

2. Sequence alignment and structure prediction
3. Applying the tools of genomics and bioinformatics in 'omics'

Course Outcomes:

At the end of this course, the students will be able to

1. Identify a genome sequence and annotate its functions
2. Design gene-based primers for target traits
3. Perform the multiple sequence alignment to identify conserved regions
4. Study the functional structure of a protein and its physiochemical properties
5. Identify the coding and non-coding sequence of a gene
6. Analyze the metabolic pathway beneath a trait to assist genomic assisted breeding

Theory

Primer on bioinformatics and computational genomics, database fundamentals viz., biological databases, horticultural genome and protein databases, functional genomics. Dynamic programming sequence alignment, BLAST search engine, FASTA search engine, Microarrays- Microarray clustering and classification, terminologies and ontologies –Eco CYC knowledge base of E. Coli metabolism - Description of UMLS semantic network. Multiple Sequence Alignment, MSA algorithm descriptions, Clustal W, 1DMotifs, Algorithms and Databases, methods for sequence weighting, BLOCKS database, making BLOCK motifs, PROSITE database, 3Dstructure alignment, SCOP, DALI, LOCK, MUSTA algorithm for geometric hashing and multiple alignment. Hidden Markov models, molecular energetics and dynamics, protein structure prediction, genetic networks - Modeling and simulation of genetic regulatory systems-KEGG database of genes and gene pathways/networks – Eco CYC database of metabolic pathways in E. Coli -EGF-signal pathway modeling, Gene finding algorithms – Genome annotation assessment project for Arabidopsis, Comparative genomics algorithms, Genome Alignment. 3D structure computations, NMR, Xtallography, NMR Structure, Determination, X-ray Crystallography structure determination, distance geometry description, RNA secondary structure, Molecular modeling and drug discovery programs. Phylogenetic algorithms – Tree base database of phylogenetic information for plants mostly, tree of life page, samples from the tree of life, ribosomal database project, natural language processing, proteomics, 3D Motifs, applications and integration with horticulture, final thoughts.

Suggested Reading

1. Attwood, T. K. and Parry Smith, D. J. (2006). *Introduction to bioinformatics*. Pearson Edu.
2. Baxevanis, A. D. (2005). *Bioinformatics: A practical guide to the analysis of genes and proteins*. 3rd Ed. Wiley.
3. Bourne, P. E. and Weissig, H. (Eds.). (2004). *Structural bioinformatics*. John Wiley & Sons.
4. Durbin, R., Eddy, S. R., Krogh, A. and Mitchison, G. (1999). *Biological sequence analysis: Probabilistic model of proteins and nucleic acids*. Cambridge Univ. Press.
5. Keshavachandran, R., Nazeem, P. A., Girija, D., John, P. S. and Peter, K. V. (2007). *Recent trends in biotechnology of horticultural crops*. Vols. I, II. New India Publ. Agency.
6. Kohane, I. S., Kho, A. and Butte, A. J. (2002). *Microarrays for an integrative genomics*. MIT Press.
7. Mount, D. W. (2001). *Bioinformatics: Sequence and genome analysis*. Cold Spring Harbour Laboratory Press.

21HO3274 STRESS MANAGEMENT IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

4. The classification of stress and its impacts
5. The crop modelling for stress situations
6. The techniques involved in the stress management

Course Outcomes:

At the end of this course, the students will be able to

7. Summarize the classification of stress
8. Discuss the metabolic changes induced by stress factors
9. Enumerate the crop modelling for stress situations
10. Describe the methods of stress management in fruit crops
11. Discuss on the water use efficiency
12. Elucidate the crop growth sustainability indices

Theory

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution - increased level of CO₂, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate, etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, Biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, Crop modelling for stress situations, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti-transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Suggested Reading:

1. Blumm, A. (1988). *Plant breeding for stress environments*. CRC.
2. Christiansen, M. N. and Lewis, C. F. (1982). *Breeding plants for less favourable environments*. Wiley Inter. Science.
3. Gupta, U. S. (1990). *Physiological aspects of dry farming*.
4. Hsiao, T. C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiology* 24:519-570.
5. Kramer, P. J. (1980). Drought stress and the origin of adaptation. In: *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.
6. Levitt, J. (1972). *Response of plants to environmental stresses*. Academic Press.
7. Maloo, S. R. (2003). *Abiotic stress and crop productivity*. Agrotech Publ. Academy.
8. Mussell, H. and Staples, R. (1979). *Stress physiology in crop plants*. Wiley Inter. Science.
9. Nickell, L. G. (1983). *Plant growth regulating Chemicals*. CRC.
10. Peter, K. V. (Ed.). (2008). *Basics of horticulture*. New India Publ. Agency.
11. Turener, N. C. and Kramer, P. J. (1980). *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.

21HO3275 ENVIRONMENTAL SCIENCE IN RELATION TO HORTICULTURE

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Environmental system and its impact on horticulture crops
2. Advances in environmental management of horticultural crops
3. Strategies in pollution management of horticulture-based industries

Course Outcomes:

At the end of this course, the students will be able to

1. Explain about the environmental systems and their impact on horticulture
2. Discuss about the geochemical and hydrological cycles
3. Outline the causes of global warming and its impact on horticulture
4. Describe about the habitat ecology and conservation
5. Discuss about the waste management in horticulture-based industries
6. Explain about the different environmental policies across the globe

Theory

Environmental complex, interaction of ecological factors in horticultural crop production, interaction of physio-graphic factors in horticultural crop production. Geo-chemical and hydrological cycles and their impact on ecosystems, assessment of plant associations in natural and domestic systems, productivity assessment of various ecosystems, analysis and assessment of various phyto geographic zones, assessment of land use changes and its impact on horticultural systems, assessment of biodiversity, pesticide residue analysis in horticultural produce, Global warming- carbon trading role of greenhouse gases, elevated CO₂ and its impact on productivity

of horticultural systems. Habitat ecology, changes in habitats and its impact on horticultural production, habitat analysis, conservation biology, domestication. Forest ecosystem and its evolution to a hort-ecosystem. Phyto-geography. changes in land use pattern and its impact on horticultural crop production. Natural resource management in horti systems. Subsistence farming systems of the world, threat and challenges. Environmental pollution in horti systems, chemicals, fertilizers, etc. Waste management in processing industry, phyto-remediation. Alternate farming systems, horticultural therapy, Environmental policy and legislation in India, International treaties and summit, biodiversity board, act, etc.

Suggested Reading

1. Ashby, M. (1973). *Introduction to plant ecology*. Mac Millan Press.
2. CSIR. (1971). *The wealth of India*. Vols. A-Z. CSIR.
3. Daubenmire, R. F. (1959). *Plants and environment*. Wiley Eastern.
4. Fall. (2001). *Tolerance of landscape plants to recycle water irrigation*. UC and ANR Publ.
5. Mathew, I. P. and Karikari, S. K. (1990). *Horticulture principles and practices*. Mac Millan Intermediate Agricultural Series.
6. Prasad, S. and Kumar, U. (2003). *Principles of horticulture*. Agrobios.
7. Sasikumar, B., Krishna Murthy, B., Rama, J., Ravindran, P. N. and Peter, K. V. (Eds.). (1999). *Biodiversity conservation and utilization of spices, medicinal and aromatic plants*. I ISR, Calicut.
8. Singh, P. P. (2006). *Perspectives in plant ecology and environmental biology*. Scien. Publ.

21HO3276 RECENT TRENDS IN FLOWER CULTIVATION PRACTICES

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Recent progresses in production technology of flower crops
2. Up-to-date scenario in production technology of flower crops
3. Improved cultivation techniques of flower crops

Course Outcomes:

At the end of this course, the students will be able to

1. Elucidate the worldwide scenario of cut flower production and trade
2. Validate the innovative propagation practices of cut flower crops
3. Plan the irrigation and fertilizer need for cut flower crops
4. Discuss the environmental parameters using advanced techniques
5. Cultivate cut flower crops under protected structures
6. Explain the methods for year-round blossoming of cut flower crops

Theory

Opportunity and status of flower crops; International trends in cut flower cultivation and market, varietal treasure and range; Soil and environment; Distinct features and requirements; cut flower, traditional flowers, dry flowers and essential oil trade. Propagation; Greenhouse management; IPR issues related to propagation of materials; Greenhouse management; Soil/media sanitization techniques; Micro irrigation; nutrition and fertigation; Special horticulture practices, impact of environmental parameters on growth and flowering; regulation for quality flowers. All year long flowering through physiological interferences; Photoperiodic and chemical induction of flowering, Maturity indices; Harvesting practices; After harvest practices; Export prospects and Preparation of floral decorative. Crop specific practices – Rose, anthurium, orchids, carnation, gladioli, gerbera, lilliums, heliconia, bird of paradise, *Jasminum* sp., marigold, tuberose, crossandra, value added products, extraction of floral concrete and oils and recent advances.

Suggested Reading

1. Bose, T. K., Maiti, R. G., Dhua, R. S. and Das, P. 1999. *Floriculture and Landscaping*. Naya Prokash.
2. Chadha, K. L. and Choudhury, B. 1992. *Ornamental horticulture in India*. ICAR.
3. George, S. and Peter, K. V. 2008. *Plants in a garden*. New India Publ. Agency.
4. Lauria, A. and Victor, H. R. 2001. *Floriculture – Fundamentals and practices*. Agrobios.
5. Randhawa, G. S. and Mukhopadhyay, A. 1986. *Floriculture in India*. Allied Publ.
6. Reddy, S., Janakiram, B., Balaji, T., Kulkarni, S. and Misra, R. L. 2007. *High tech floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

21HO3277 RECENT TRENDS IN BREEDING OF FLOWER CROPS

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Improved techniques in hybridization of flower crops
2. Breeding accomplishments in development of flower crops
3. New research techniques in the field of breeding of flower crops

Course Outcomes:

At the end of this course, the students will be able to

1. Create the breeding objectives for flower crops
2. Explain the various breeding methods of flower crops
3. Describe the genetic systems of flower crops
4. Frame the breeding techniques for management of stresses
5. Create the breeding techniques for management of pests and diseases in flower crops
6. Elucidate the incompatibility system of flower crops

Theory

Breeding techniques related to novel colour development, improvement in flower size, doubleness, fragrance and extending the after harvesting practices, IPR in flower crops. Specific aims of breeding in flower crops, methods of breeding suited to seed and vegetatively propagated flower crops in the evolution of novel varieties, exploitation of heterosis, utilization of male sterility-Incompatibility mechanisms, breeding under controlled conditions. Floral biology, hybridization techniques. Breeding for resistance to pests, diseases, nematodes in flower crops. Induction of mutants; physical and chemical mutagens; Induction of polyploidy. Screening of plants for biotic and abiotic stresses. Crop specific breeding complications and accomplishments made in rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, gerbera, gladioli, orchids and anthurium. Specific breeding problems and achievements made in aster, petunia, lilliums, heliconia, bird of paradise, hibiscus and bougainvillea, Description of crops and cultivars.

Suggested Reading

1. Arora, J. S. (2006). *Introductory ornamental horticulture*. Kalyani.
2. Bhattacharjee, S. K. (2006). *Advances in ornamental horticulture*. Vols. I-VI. Pointer Publ.
3. Choudhary, R. C. (1993). *Introduction to plant breeding*. Oxford & IBH.
4. Singh, B. D. (1990). *Plant breeding*. Kalyani.

21HO3278 RECENT TRENDS IN LANDSCAPE ARCHITECTURE

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. New technologies in the field of landscape architecture
2. Evolving hands-on skills in the field of landscape architecture
3. Eco-friendly landscaping practices

Course Outcomes:

At the end of this course, the students will be able to

1. Formulate the different garden styles
2. Make a plan for lawn making
3. Demonstrate water gardening, etc
4. Elaborate the environmental control systems in greenhouse
5. Describe the techniques involved in institutional landscaping
6. Prepare the landscaping project

Theory

Plant identification, types of gardens, garden design making by different garden styles and types. Materials of garden design, way of designing a commercial landscape project, topographical survey and designing concept. Preparation and drawing of site plan, learning the basics in computer aided design (CAD) for developing a garden landscape plan, handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing. Contemporary landscaping, environmental landscaping, industrial and institutional landscaping, Public and private garden making, playground landscaping, case study with the successful landscapist, budget / project cost estimating, execution strategies, assessing a successful design in site.

Suggested Reading

1. Bose, T. K., Maiti, R. G., Dhua, R. S. and Das, P. (1999). *Floriculture and landscaping*. Naya Prokash.
2. Nambisan, K. M. P. (1992). *Design elements of landscape gardening*. Oxford & IBH.

21HO3279 RECENT TRENDS IN PROTECTED AND PRECISION FLORICULTURE

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Growing flower crops in protected structures
2. Flower crops under precision farming practices
3. Role of electronic device in precision farming

Course Outcomes:

At the end of this course, the students will be able to

1. Elucidate the scenarios of protected floriculture in India
2. Designate the environmental control techniques in green house
3. Describe the status of GPS, GIS in precision floriculture
4. Explain the environmental parameters using advanced techniques
5. Describe the flower crops cultivation under precision farming system
6. Outline the after harvesting methods in flower crops

Theory

Scenarios of protected floriculture in India, basic considerations in establishment and operation, environmental control system of protected structures. Containers, substrate culture, soil decontamination techniques. Crop maintenance practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, lilies, cut foliage; Harvesting, after-harvest handling, marketing, export. Precision floriculture, ideologies and technologies of precision farming, precision equipment's, GPS, GIS, remote sensing, sensors. Variability management in precision farming, mapping, variable rate technology and precision equipment's in precision farming, post-harvest process management in floriculture using precision farming.

Suggested Reading

1. Bhattacharjee, S. K. (2006). *Advances in ornamental horticulture*. Vols. I-VI. Pointer Publ.
2. Bose, T. K., Maiti, R. G., Dhua, R. S. & Das, P. (1999). *Floriculture and landscaping*. Naya Prokash.
3. Reddy, S., Janakiram, B., Balaji, T., Kulkarni, S., & Misra, R. L. (2007). *High-tech floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

21HO3280 RECENT TRENDS IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Biochemistry of flower crops
2. Uses of biotechnology in flower crops
3. Biotic and abiotic stress management techniques in flower crops

Course Outcomes:

At the end of this course, the students will be able to

1. Describe the biochemistry of flower crops
2. Discuss bio colours and their value addition
3. Describe *in vitro* lines for biotic and abiotic stress management in flower crops
4. Explain the somoclonal variation and its applications
5. Discuss the gene cloning
6. Explain genetic engineering

Theory

Principle involved in the formation of pigments. Chemistry and importance of secondary metabolites in rose, jasmine, marigold, tuberose, carnation, orchids, lilies and bougainvillea. Plant nutrient stock, growth regulators, media preparation and sterilization techniques. Biochemistry and utilization of commercial products (select items). Recent trends in value addition of flower crops, uses in food and textile industries. Biochemistry of post-harvest management of cut flowers. Biotechnology tools, techniques and

role in floriculture industry. *In vitro* lines for biotic and abiotic, production of haploids, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, *in vitro* pollination and fertilization, hardening media, techniques and establishment of tissue culture plants in the primary and secondary nursery. Somoclonal variation and its applications. Gene cloning, genetic engineering. Construction of c- DNA library, DNA fingerprinting technique to improve post-harvest life of flowers, ornamental plants.

Suggested Reading

1. Chopra, V. L. and Nasim. (1990). *Genetic engineering and biotechnology –Concepts, methods and applications*. Oxford & IBH.
2. Debnath, M. (2005). *Tools and techniques of biotechnology*. Pointer Publ.
3. Dey, P. M. and Harborne, J. B. (1997). *Plant biochemistry*. 2nd Ed. Academic Press.
4. Glover, M. D. (1984). *Gene cloning: The mechanics of DNA Manipulation*. Chapman & Hall.
5. Goodwin, T. W. and Mercer, E. I. (2003). *Introduction to plant biochemistry*. CBS.
6. Gorden, H. and Rubsell, S. (1960). *Hormones and cell culture*. AB Book Publ.
7. Keshavachandran, R. and Peter, K. V. (2008). *Plant biotechnology: Methods in tissue culture and gene transfer*. Orient & Longman (Universal Press).
8. Keshavachandran, R., Nazeem, P. A., Girija, D., John, P. S. and Peter, K. V. (Eds.). (2007). Recent trends in horticultural biotechnology. Vols. I, II. New India Publishing Agency.
9. Panopoulos, N. J. (Ed.). (1981). *Genetic engineering in plant sciences*. Praeger Publ.
10. Parthasarathy, V. A., Bose, T. K., Deka, P. C., Das, P., Mitra, S. K. and Mohanadas, S. 2001. *Biotechnology of horticultural Crops*. Vols. I-III. Naya Prokash.
11. Pierik, R. L. M. (1987). *In vitro culture of higher plants*. Martinus Nijhoff Publ.
12. Prasad, S. (1999). *Impact of plant biotechnology on horticulture*. 2nd Ed. Agro Botanica.
13. Sharma, R. (2000). *Plant tissue culture*. Campus Books International.
14. Singh, B. D. (2001). *Biotechnology*. Kalyani.
15. Skoog, Y. and Miller, C. O. (1957). *Chemical regulation of growth and formation in plant tissue culture in vitro*. Symp. Soc. Exp. Biol. 11: 118-131.
16. Vasil, T. K., Vasi, M., While, D. N. R and Bery, H. R. (1979). *Somatic hybridization and genetic manipulation in plants. Plant regulation and world agriculture*. Planum Press.
17. Williamson, R. (1981-86). *Genetic engineering*. Vols. I-V.

21HO3281 CONTROL OF BIOTIC AND ABIOTIC STRESS IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. The types of stress and its effects in horticultural crops
2. Modelling of crops for various stress conditions
3. The approaches involved in the stress management

Course Outcomes:

At the end of this course, the students will be able to

1. Explain the classification of stress
2. Discuss the metabolic changes induced by stress factors
3. List the crop modelling strategies for stress conditions
4. Illustrate the methods of stress management in fruit crops
5. Understand the water use efficiency
6. Enumerate the crop growth sustainability indices

Theory

Stress – Biotic and abiotic, causes of stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution: causes and impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Crop modelling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Abiotic stresses, types and management practices. Rain water harvesting techniques to alleviate different stress situations.

Suggested Reading

1. Blumm, A. (1988). *Plant breeding for stress environments*. CRC.

2. Christiansen, M. N. and Lewis, C. F. (1982). *Breeding plants for less favourable environments*. Wiley Inter. Science.
3. Gupta, U. S. (1990). *Physiological aspects of dry farming*.
4. Hsiao, T. C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiology* 24:519-570.
5. Kramer, P. J. (1980). Drought stress and the origin of adaptation. In: *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.
6. Levitt, J. (1972). *Response of plants to environmental stresses*. Academic Press.
7. Maloo, S. R. (2003). *Abiotic stress and crop productivity*. Agrotech Publ. Academy.
8. Mussell, H. and Staples, R. (1979). *Stress physiology in crop plants*. Wiley Inter. Science.
9. Nickell, L. G. (1983). *Plant growth regulating Chemicals*. CRC.
10. Peter, K. V. (Ed.). (2008). *Basics of horticulture*. New India Publ. Agency.
11. Turener, N. C. and Kramer, P. J. (1980). *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.

21HO3282 RECENT TRENDS IN VEGETABLE PRODUCTION

Credits: 3 (3+0)

Course Objectives:

To impart basic knowledge on

1. Latest developments and trends in production technology of major tropical and subtropical vegetables
2. The strategies of protected cultivation and seedling production of vegetables
3. The latest techniques of soil, crop and nutrient management in vegetables

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the recent trends in research in production technology of vegetables
2. Identify the problems associated with vegetable cultivation and take up location specific advanced research programmes
3. Enumerate the use of nanotechnology, biotechnology and IT tools in vegetable production
4. Demonstrate the use of new generation products and formulations in vegetable farming
5. Discuss the role of training, pruning and crop modulation procedures to enhance productivity of vegetables
6. Elucidate the methods of low cost, input efficient agro techniques to enhance productivity of vegetables

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of Crops viz., Tomato, brinjal, chilli, sweet pepper and potato, cucurbits, cabbage, cauliflower and knol-khol, bhendi, onion, cowpea, green peas and beans, amaranthus and drumstick, carrot, beet root and radish, sweet potato, tapioca, elephant foot yam and taro. Vegetable waste recycling management; quality analysis; marketing survey of the above crops; visit to vegetable and fruit markets and packinghouses.

Suggested Reading

1. Bose, T. K. and Som, N. G. (1986). *Vegetable crops of India*. Naya Prokash.
2. Bose, T. K., Kabir, J., Maity, T. K., Parthasarathy, V. A. and Som, M. G. (2003). *Vegetable crops*. Vols. I-III. Naya Udyog.
3. Brewster, J. L. (1994). *Onions and other Vegetable Alliums*. CABI.
4. FFTC. *Improved vegetable production in Asia*. Book Series No. 36.
5. Ghosh, S. P., Ramanujam, T., Jos, J. S., Moorthy, S. N. and Nair, R. G. (1988). *Tubercrops*. Oxford & IBH.
6. Gopalakrishnan, T. R. (2007). *Vegetable Crops*. New India Publishing Agency.
7. Kallo, G. and Singh, K. (Ed.). (2001). *Emerging scenario in vegetable research and development*. Research Periodicals & Book Publ. House.

8. Kurup, G. T., Palanisami, M. S., Potty, V. P., Padmaja, G., Kabeerathuma, S. and Pallai, S. V. (1996). *Tropical tuber crops, problems, prospects and future strategies*. Oxford & IBH.
9. Sin, M. T. and Onwueme, I. C. (1978). *The tropical tuber crops*. John Wiley & Sons.
10. Singh, N. P., Bhardwaj, A. K., Kumar, A. and Singh, K. M. (2004). *Modern technology on vegetable production*. International Book Distr. Co.
11. Singh, P. K., Dasgupta, S. K. and Tripathi, S. K. (2006). *Hybrid vegetable development*. International Book Distr. Co.

21HO3283 RECENT TRENDS IN BREEDING OF VEGETABLE CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. Recent trends in breeding of tropical, subtropical and temperate vegetable crops grown in India
2. The strategies of holistic breeding methods involving traditional and molecular methods of breeding
3. The biotechnological tools in vegetable breeding

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the recent trends in breeding of vegetable crops
2. Identify the recent trends in breeding objectives of vegetable crops
3. Enumerate the use of molecular markers in stress resistance breeding
4. Demonstrate the techniques of biotechnological tools in vegetable breeding
5. Discuss the role of a holistic breeding strategy for vegetable improvement
6. Elucidate the breeding strategy for climate change adaptation of vegetables

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, inter-specific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding, biotechnological tools in breeding and their achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for pest, disease, nematode and multiple resistance; Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for quality improvement of: Crops viz., Tomato, brinjal, chilli, sweet pepper and potato cucurbits, cabbage, cauliflower and knol-khol, bhendi, onion, peas and beans, amaranthus and drumstick, carrot, beet root and radish, sweet potato, tapioca, elephant foot yam and taro.

Suggested Reading

1. *Acta Horticulture*. Conference on Recent advance in vegetable crops. Vol.127.
2. Chadha, K. L., Ravindran, P. N. and Sahijram, L. (2000). *Biotechnology in horticultural and plantation crops*. Malhotra Publ. House.
3. Chadha, K. L. (2001). *Hand book of horticulture*. ICAR.
4. Dhillon, B. S., Tyagi, R. K., Saxena, S. and Randhawa, G. J. (2005). *Plant genetic resources: Horticultural crops*. Narosa Publ. House.
5. Janick, J. J. (1986). *Horticultural Science*. 4th Ed. WH Freeman & Co.
6. Kaloo, G. and Singh, K. (2001). *Emerging scenario in vegetable research and development*. Research Periodicals and Book Publ. House.
7. Kaloo, G. (1994). *Vegetable breeding*. Vols. I-III. Vedamse Books.
8. Peter, K. V. and Pradeep Kumar T. (2008). *Genetics and breeding of vegetables*. (Revised Ed.). ICAR.
9. Ram, H. H. (2001). *Vegetable breeding*. Kalyani.

21HO3284 PROTECTED CULTIVATION OF VEGETABLE CROPS

Credits: 2 (1+1)

Course Objectives:

To impart basic knowledge on

1. Recent trends in growing of vegetable crops under protected environmental conditions
2. The strategies of developing location specific protected structures for vegetable cultivation

3. The techniques of crop management in protected cultivation

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the recent trends in growing of vegetable crops under protected environmental conditions
2. Identify appropriate location specific protected structures for vegetable cultivation
3. Production of seeds and seedlings in protected structures
4. Demonstrate the appropriate agro-techniques in protected cultivation
5. Nutrient and soil management for vegetable cultivation in protected structures
6. Designing appropriate protected structures

Theory

Importance and scope of protected cultivation of vegetable crops; principles of protected cultivation, energy management, low-cost structures; training methods; engineering aspects. Regulatory structures used in protected structures; types of greenhouse/ polyhouse/ net house, hotbeds, cold frames, effect of environmental factors and methods to control temperature, light, CO₂ and humidity on growth of different vegetables, manipulation of CO₂, light and temperature for vegetable production, fertigation. Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover. Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures. Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production, Crops viz., Tomato, capsicum, cucumber, melons and lettuce. Visit to established green/polyhouse/net house/shade house in the region.

Suggested Reading

1. Anonymous. (2003). *Proc. All India seminar on potential and prospects for protective cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.
2. Chandra, S. and Som, V. (2000). *Cultivating vegetables in green house*. Indian Horticulture.
3. Prasad, S. and Kumar, U. (2005). *Greenhouse management for horticultural crops*. 2nd Ed. Agrobios.
4. Tiwari, G. N. (2003). *Green house technology for controlled environment*. Narosa Publ. House.

21HO3285 BIOTECHNOLOGY IN VEGETABLE CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. Recent trends in biotechnology tools for crop improvement of vegetable crops
2. Development of vegetable varieties with biotic and abiotic resistance
3. Utilization of biotechnological tools in vegetable breeding and classification

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the recent trends in biotechnology tools employed in crop improvement of vegetable crops
2. Identify the strategy for development of vegetable varieties with biotic and abiotic resistance
3. Utilize the traditional and modern methods of crop improvement in vegetables
4. Demonstrate the use of molecular markers in vegetable breeding and classification
5. Discuss the role of nano products in vegetable production
6. Develop location specific varieties for climate change resilience

Theory

In vitro culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somocloning and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites. Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation. *In vitro* mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology. Quality improvement, improvement for biotic and abiotic stresses, transgenic plants. Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology with special reference to Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

Suggested Reading

1. Bajaj, Y. P. S. (Ed.). (1987). *Biotechnology in agriculture and forestry*. Vol. XIX. *Hitech and Micropropagation*. Springer.
2. Chadha, K. L., Ravindran, P. N. and Sahijram, L. (Eds.). (2000). *Biotechnology of horticulture and plantation crops*. Malhotra Publ. House.
3. Debnath, M. (2005). *Tools and techniques of biotechnology*. Pointer Publ.
4. Glover, M. D. (1984). *Gene Cloning: The mechanics of DNA manipulation*. Chapman & Hall.
5. Gordon, H. and Rubsell, S. (1960). *Hormones and cell culture*. AB Book Publ.
6. Keshavachandran, R. and Peter, K. V. (2008). *Plant biotechnology: Tissue culture and gene transfer*. Orient & Longman (Universal Press).
7. Keshavachandran, R. *et al.* (2007). *Recent trends in biotechnology of horticultural crops*. New India Publ. Agency.
8. Panopoulos, N. J. (Ed.). (1981). *Genetic engineering in plant sciences*. Praeger Publ.
9. Parthasarathy, V. A., Bose, T. K., Deka, P. C., Das, P., Mitra, S. K. and Mohanadas, S. 2001. *Biotechnology of horticultural crops*. Vols. I-III. Naya Prokash.
10. Pierik, R. L. M. (1987). *In vitro culture of higher plants*. Martinus Nijhoff Publ.
11. Prasad, S. (1999). *Impact of plant biotechnology on horticulture*. 2nd Ed. Agro Botanica.

21HO3286 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS

Credits: 2 (1+1)

Course Objectives:

To impart basic knowledge on

1. Recent trends in the seed certification, processing and storage of vegetable crops
2. Advances in physiological and biochemical process of seed aging
3. The techniques of seed production, seed treatment and packing

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the recent trends in seed production technology of major vegetable crops
2. Recent trends in research on seed deterioration
3. Enumerate the procedures for seed certification
4. Demonstrate the techniques of seed treatment and advances in research
5. Discuss the role of new seed policy and seed industry and farmers
6. Elucidate the measures for seed quality enhancement in vegetables

Theory

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification. Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number. Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control. Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy. Handling of seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy. (With specific reference /examples of cucurbits, solanaceous, leguminous, cruciferous, bulb, root, leaf and tuber crops). Visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

Suggested Reading

1. Agrawal, P. K. and Dadlani, M. (1992). *Techniques in seed science and technology*. South Asian Publ.
2. Singh, N., Singh, D. K., Singh, Y. K. and Kumar, V. (2006). *Vegetable seed production technology*. International Book Distr. Co.
3. Singh, S. P. (2001). *Seed production of commercial vegetables*. Agrotech Publ. Academy.

4. Tanwar, N. S. and Singh, S. V. (1988). *Indian minimum seed certification standards*. Central Seed Certification Board, GOI, New Delhi.
5. Rajan, S. and Baby, L. Markose (2007). *Propagation of horticultural Crops*. New India Publ. Agency.

21HO3287 CONTROL OF BIOTIC AND ABIOTIC STRESS IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. The types of stress and its effects in horticultural crops
2. Modelling of crops for various stress conditions
3. The approaches involved in the stress management

Course Outcomes:

At the end of this course, the students will be able to

1. Explain the classification of stress
2. Discuss the metabolic changes induced by stress factors
3. List the crop modelling strategies for stress conditions
4. Illustrate the methods of stress management in fruit crops
5. Understand the water use efficiency
6. Enumerate the crop growth sustainability indices

Theory

Stress – Biotic and abiotic, causes of stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution: causes and impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Crop modelling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Abiotic stresses, types and management practices. Rain water harvesting techniques to alleviate different stress situations.

Suggested Reading

1. Blumm, A. (1988). *Plant breeding for stress environments*. CRC.
2. Christiansen, M. N. and Lewis, C. F. (1982). *Breeding plants for less favourable environments*. Wiley Inter. Science.
3. Gupta, U. S. (1990). *Physiological aspects of dry farming*.
4. Hsiao, T. C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiology* 24:519-570.
5. Kramer, P. J. (1980). Drought stress and the origin of adaptation. In: *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.
6. Levitt, J. (1972). *Response of plants to environmental stresses*. Academic Press.
7. Maloo, S. R. (2003). *Abiotic stress and crop productivity*. Agrotech Publ. Academy.
8. Mussell, H. and Staples, R. (1979). *Stress physiology in crop plants*. Wiley Inter. Science.
9. Nickell, L. G. (1983). *Plant growth regulating Chemicals*. CRC.
10. Peter, K. V. (Ed.). (2008). *Basics of horticulture*. New India Publ. Agency.
11. Turener, N. C. and Kramer, P. J. (1980). *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.

21HO3288 ADVANCES IN PRODUCTION TECHNOLOGY OF PLANTATION CROPS

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Importance and export potential of plantation crops grown in India
2. Advanced production technology of plantation crops grown in India
3. Varietal wealth of plantation crops

Course Outcomes:

At the end of this course, the students will be able to

1. Describe the export potential of plantation crops
2. Describe the important varieties of plantation crops
3. Demonstrate the propagation methods in plantation crops

4. Explain about the advanced production technology of plantation crops
5. Describe the advanced post-harvest practices and value addition in plantation crops
6. Outline the GAP, GMP and HACCP practices in important plantation crops

Theory

Plantation crops – area and production, export potential - description of botanical and varietal features, appraisal on the crop improvement in plantation crops. Selection of mother palms and elite clones, clonal fidelity testing, nursery techniques and propagation methods mass multiplication techniques, high density planting, systems of cultivation, multitier cropping, companion cropping, studies of on canopy and root management, training and pruning practices, photosynthetic efficiencies of crops at different tiers, biotic and abiotic factors on growth and productivity, nutritional requirements, role of macro and micro nutrients, nutrient deficiency symptoms, growth regulators, water requirement, fertigation, soil and moisture conservation practices, shade regulation, drought management, permanent vegetation management, basin management, maturity indices, harvesting, curing, processing and value addition, grading, packing and storage, role of commodity boards in plantation crop development, production of plantation crops through GAP, GMP, HACCP in coffee, tea, cashew, cocoa, rubber, palmyrah, oil palm, coconut, arecanut, wattle and betelvine. Project preparation for establishing new plantations, visit to plantation gardens, commodity boards and plantation-based industries.

Suggested Reading

1. Anonymous (1985). *Rubber and its cultivation*. The Rubber Board of India.
2. Grimwood, B. E. (1975). *Coconut palm products*. FAO.
3. Kurian, A. and Peter, K. V. (2007). *Commercial crops technology*. New India Pub/. Agency.
4. Pradeep Kumar, T., Suma, B., Jyothi bhaskar and Satheesan, K. N. (2008). *Management of horticulture crops Part I, II*. New India Publ. Agency.
5. Ranganathan, V. (1979). *Hand book of tea cultivation*. UPASI, Tea Res, Stn.
6. Thampan, P.K. (1981). *Hand book of coconut palm*. Oxford & IBH

21HO3289 ADVANCES IN PRODUCTION TECHNOLOGY OF SPICE CROPS

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

1. Importance and export potential of plantation crops grown in India
2. Advanced production technology of plantation crops grown in India
3. Varietal wealth of plantation crops

Course Outcomes:

At the end of this course, the students will be able to

1. Describe the importance and global scenario of spice crops
2. Discuss the important varieties of spice crops
3. Demonstrate the nursery management practices in spice crops
4. Explain about the advanced production technology of spice crops
5. Describe the advanced post-harvest practices and value addition in spice crops
6. Discuss the GAP and GMP practices in important spice crops

Theory

Spices- current status on area and production, state, national and global scenario of spices, global trade, problems encountered in spices productivity, systems of cultivation, botanical description of spice crops, varieties, soil and climate, propagation techniques and nursery management, planting systems and methods, cropping pattern, permanent floor management concepts in mulching and weed management, canopy and root studies under different spice-based cropping systems, shade and basin management, INM practices, irrigation and fertigation techniques, chemical regulation of crop productivity, IPM, clean cultivation strategies, harvesting, post-harvest and quality management for value added spices, quality standards, GAP and GMP for spices production, quality control and certification. Protected cultivation of high value spice crops. Value addition and by-product utilization. Precision farming and organic farming in spice crops such as pepper, cardamom, nutmeg, clove, cinnamon, allspice, turmeric, ginger, garcinia, tamarind, garlic, coriander, fenugreek, fennel, cumin, vanilla, paprika and important herbal plants. Commodity Boards in spices development

Suggested Reading

1. Chadha, K.L. (2001). *Hand book of horticulture*. ICAR

- George, C.K. (Ed.). (1989). *Proceedings of first national seminar on seed spices*. Spices Board, Ministry of Commerce, Govt. of India, Kochi
- Parry, J.W. (1969). *Spices and condiments*. Pitman.
- Peter, K.V. (2001). *Hand book of herbs and spices* 1(3). Woodhead Publ Co UK. and CRC USA.
- Ridley, H.M. 1972. *Spices*. Mac Millan.
- Shanmugavelu, K.G., Kumar, N. and Peter, K.V. (2002). *Production technology of spices and plantation crops*. Agrobios
- Varmudy, V. (2001). *Marketing of spices*. Daya Publ. House.

21HO3290 ADVANCES IN PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS

Credits: 3 (3+0)

Course Objectives:

To impart knowledge on

- Genetic diversity and importance of medicinal and aromatic crops grown in India
- Production and post-harvest technology of medicinal and aromatic crops grown in India
- Varietal wealth of medicinal and aromatic crops

Course Outcomes:

At the end of this course, the students will be able to

- Describe the importance and conservation of medicinal and aromatic crops
- Explain about the advanced research methods in medicinal and aromatic crops
- Describe about the important varieties of medicinal and aromatic crops
- Explain about the production technology of medicinal and aromatic crops
- Describe the harvesting and post-harvest practices in medicinal and aromatic crops
- Discuss the GAP, GCP and GMP practices in medicinal and aromatic crops

Theory

Genetic biodiversity of medicinal plants, conservation networks, global initiatives on medicinal plants conservation and development, World history on usage of medicinal plants, Preference to natural products, Advanced research in biomedicines, Nutraceuticals and natural drugs, American, European and Asian legislations on plant drugs, Intellectual Property Rights, Patents. Indian traditional wisdom and Heritage- Indian herbal wealth, documentations, databases, scientific validation, production problems of medicinal and aromatic plants, export and import status. WTO scenario - Principles and guidelines for GAP, GCP and GMP in medicinal crops. climate, soil and substrate culture, improved varieties, organic production, nutrition and irrigation requirements, inter culture, mulching, weed control, maturity indices and harvesting, post-harvest handling, drying, processing, grading, packing and storage, quality standards in medicinal plants, biotechnological approaches for advances in phytochemical extraction technologies, separation of bio-molecules, distillation methods, essential oil extraction and value addition in aromatic plants, phytochemicals and drug development. Medicinal crops: *Coleus forskohlii*, glory lily, senna, periwinkle, *Stevia rebaudiana*, aswagandha, sarpagandha, *Aloe vera*, *Dioscorea* sp, *Phyllanthus amarus*, *Andrographis paniculata*, medicinal solanum, isabgol, poppy, *Digitalis* sp, *Commiphora* sp, *ipecac*, *henbane*, *Ocimum* sp., *centella*, *bacopa*, *Saraca indica* and *bael*. Aromatic crops: Palmarosa, lemongrass, citronella, vetiver, geranium, artemisia, mentha, ocimum, eucalyptus, rosemary, thyme, patchouli.

Suggested Reading

- Dharamvir, H. 2007. *Bioactive medicinal plants*. Gene Tech Books.
- Farooqi, A. A., Khan, M. M. and Vasundhara, M. (2001). *Production technology of medicinal and aromatic crops*. Natural Remedies Pvt. Ltd.
- Farooqi, A. A. and Sriram, A. H. (2000). *Cultivation practices for medicinal and aromatic crops*. Orient Longman Publ.
- Jain, S. K. (2000). *Medicinal plants*. National Book Trust.
- Panda, H. (2002). *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.
- Prajapati, N. D., Paero Hit, S. S., Sharma, A. K., and Kumar, T. (2006). *A hand book of medicinal plants*. Agro Bioss.

21HO3291 ADVANCES IN BREEDING METHODS OF PLANTATION AND SPICE CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. The principles and advances in breeding of plantation crops
2. The principles and advances in breeding of spice crops
3. Biotechnological approaches in breeding of plantation and spice crops

Course Outcomes:

At the end of this course, the students will be able to

1. Describe about the species and cultivars of plantation and spice crops
2. Explain about the pollination and fertilization mechanisms in plantation and spice crops
3. Describe the approaches for crop improvement in plantation and spice crops
4. Explain about the different advancements in breeding of plantation crops
5. Explain about the different advancements in breeding of spice crops
6. Explain the biotechnological approaches in improvement of plantation and spice crops

Theory

Evolutionary mechanisms, adaptation and domestication, genetic resources, genetic divergence, cytogenetics, variations and natural selection, types of pollination and fertilization mechanisms, sterility and incompatibility system, recent advances in crop improvement efforts, introduction and selection, chimeras, clonal selections, intergeneric, interspecific and intervarietal hybridization, heterosis breeding, mutation and polyploidy breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, genetics of important traits and their inheritance pattern, molecular and transgenic approaches and other biotechnological tools in improvement of selected spice and plantation crops in coffee, tea, cashew and cocoa, rubber, palmyrah and oil palm, coconut, arecanut, black pepper and cardamom, nutmeg, clove, cinnamon, allspice, turmeric, ginger, garcinia, tamarind, garlic, coriander, fenugreek, fennel, cumin and vanilla.

Suggested Reading

1. Chadha, K. L. (1998). *Advances in horticulture*. Vol. IX, X. *Plantation and Spices Crops*. Malhotra Publ. House.
2. Chadha, K. L., Ravindran, P. N. and Sahijram, L. (2000). *Biotechnology in horticultural and plantation crops*. Malhotra Publ. House.
3. Chadha, K. L. (2001). *Hand book of horticulture*. ICAR.
4. Chopra, V. L. and Peter, K.V. (2002). *Handbook of industrial crops*. Haworth Press, USA & Panama International Publ. (Indian Ed.).
5. Damodaran, V. K., Vilaschandran, T. and Valsalakumari, P. K. (1979). *Research on cashew in India*. KAU, Trichur.
6. George, C. K. (Ed.). (1989). *Proceedings of first national seminar on seed spices*. Spices Board, Ministry of Commerce, Govt. of India, Kochi.
7. Harver, A. E. (1962). *Modern coffee production*. Leonard Hoff (Book) Ltd.
8. Purseglove, J. W. (1968). *Tropical crops – Dictyledons*. Longman.
9. Purseglove, J. W., Brown, E. G., Green, C. L. and Robbins, S. R. J. (1984). *Spices*. Vols. I, II. Longman.
10. Peter, K. V. (2001). *Handbook of herbs and spices*. Vols. I-III. Woodhead Publ. Co., UK & CRC, USA.
11. Raj, P. S. and Vidyachandra, B. (1981). *Review of work done on cashew*. UAS Research Series No.6, Bangalore.
12. Ravindran, P. N. (2001). *Monograph on black pepper*. CRC Press.
13. Ravindran, P. N. and Madhusoodanan, K. J. (2002). *Cardamom, The genus Elettaria series on medicinal and aromatic plants – Industrial Profiles*. Routledge, UK.
14. Rosengarten, F Jr. (1969). *The book of spices*. Wynnewood; Livingston Publ. Co.
15. Shanmugavelu, K. G., Kumar, N. and Peter, K.V. (2002). *Production technology of spices and plantation crops*. Agrobios.

21HO3292 ADVANCES IN BREEDING METHODS OF MEDICINAL AND AROMATIC CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. The principles and advances in breeding of medicinal crops

2. The principles and advances in breeding of aromatic crops
3. Biotechnological approaches in breeding of medicinal and aromatic crops

Course Outcomes:

At the end of this course, the students will be able to

1. Describe about the species and cultivars of medicinal and aromatic crops
2. Discuss about the genetic mechanism associated with secondary metabolites in medicinal and aromatic crops
3. Describe the approaches for crop improvement in medicinal and aromatic crops
4. Explain about the advances in breeding of medicinal and aromatic crops
5. Explain about the biotechnological approaches in improvement of medicinal and aromatic crops
6. Explain about the specific breeding objectives in medicinal and aromatic crops

Theory

Origin and evolution of varieties, distribution- Genetic resources, genetic divergence, plant introduction, selection and domestication - Inheritance of important characters, genetic mechanisms associated with alkaloids and secondary metabolites. Methods of breeding suited to seed and vegetative propagated crops. Polyploidy and mutation breeding in the evolution of new varieties, exploitation of heterosis, utilization of male sterility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops. Specific breeding objectives in medicinal and aromatic crops, genetic bio diversity, breeding problems and improvements in senna, periwinkle, aswagandha, isabgol, sarvagandha, poppy, glory lily, *coleus*, *mucuna* and *ocimum*, centella, bacopa, dioscorea, solanum, andrographis, *aloevera*, phyllanthus, eucalyptus, bael, cinchona. Specific breeding objectives in medicinal and aromatic crops, genetic bio diversity, breeding problems and improvements in Henbane aromatic grasses, geranium, patchouli, artemisia, rosemary, thyme, sage, marjoram, fever few. Biotechnological approaches for crop improvement of medicinal and aromatic crops.

Suggested Reading

1. Atal, C. K. and Kapur, B. M. (1982). *Cultivation and utilization of medicinal plants*. RRL, CSIR, Jammu.
2. Chadha, K. L. and Gupta, R. (1995). *Advances in horticulture*. Vol. XI. Malhotra Publ. House.
3. Farooqi, A. A., Khan, M. M. and Vasundhara, M. (2001). *Production technology of medicinal and aromatic crops*. Natural Remedies Pvt. Ltd.
4. Handa, S. S. and Kaul, M. K. (1982). *Cultivation and utilization of medicinal plants*. NISC, CSIR.
5. Jain, S. K. (2000). *Medicinal plants*. National Book Trust.
6. Julia, F. and Charters, M. C. (1997). *Major medicinal plants – Botany, Cultures and Uses*. Thomas Publ.
7. Prajapati, N. D., Paero Hit, S. S., Sharma. A. K., Kumar, T. (2006). *A hand book of medicinal plants*. Agro Bios (India).
8. Thakur, R. S., Pauri, H. S. and Hussain, A. (1989). *Major medicinal plants of India*. CSIR.

21HO3293 ADVANCES IN BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. The classification of stress and its impacts
2. The crop modelling for stress situations
3. The techniques involved in the stress management

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the classification of stress
2. Discuss the metabolic changes induced by stress factors
3. Enumerate the crop modelling for stress situations
4. Describe the methods of stress management in fruit crops
5. Discuss on the water use efficiency
6. Elucidate the crop growth sustainability indices

Theory

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution - increased level

of CO₂, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate, etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, crop modelling for stress situations, cropping system, container seedling production assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Greenhouse effect and methane emission and its relevance to abiotic stresses, seed treatment/hardening practices, use of anti-transpirants and PGRs in stress management, analysis of soil moisture estimates, modeo-faction and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices, economics of stress management, case studies on orchards and watershed locations.

Suggested Reading

1. Blumm, A. (1988). *Plant breeding for stress environments*. CRC.
2. Christiansen, M. N. and Lewis, C. F. (1982). *Breeding plants for less favourable environments*. Wiley Inter. Science.
3. Gupta, U. S. (1990). *Physiological aspects of dry farming*.
4. Hsiao, T. C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiology* 24:519-570.
5. Kramer, P. J. (1980). Drought stress and the origin of adaptation. In: *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.
6. Levitt, J. (1972). *Response of plants to environmental stresses*. Academic Press.
7. Maloo, S. R. (2003). *Abiotic stress and crop productivity*. Agrotech Publ. Academy.
8. Mussell, H. and Staples, R. (1979). *Stress physiology in crop plants*. Wiley Inter. Science.
9. Nickell, L. G. (1983). *Plant growth regulating Chemicals*. CRC.
10. Peter, K. V. (Ed.). (2008). *Basics of horticulture*. New India Publ. Agency.
11. Turener, N. C. and Kramer, P. J. (1980). *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.

21HO3294 NOVEL PROCESSING TECHNOLOGIES FOR HORTICULTURAL PRODUCE

Credits: 3 (3+0)

Course Objectives:

To impart basic knowledge on

1. Recent advances made in the food processing industries
2. Functional food and nutraceuticals
3. Beneficial role of microbes in food industry

Course Outcomes:

At the end of this course, the students will be able to

1. Elaborate the minimal processing concept of food
2. Enumerate the role of recent methods of food processing
3. Explain the benefits and advantages of making functional food and nutraceuticals
4. Enumerate the importance of genetically engineered microbes in food industry
5. Develop innovative methods of fortification of food
6. Acquire the skills on freeze preservation

Theory

Recent advances in processing technologies: Aseptic processing, individual quick freezing and cryogenic freezing and recent trends in freeze preservation, membrane technology, extrusion cooking, vacuum frying, ohmic heating, microwave processing and dielectric heating and thermal process calculations. Determination of thermal resistance of bacteria TDT and TDP and determination of thermal death curve. Non thermal processing -Irradiation, pulsed electric field, magnetic fields, pulsed light treatment, high pressure processing, ultrasound, linear induction electron accelerator (LIEA), SCFE, ozonation, minimal processing and hurdle technology and study of problems associated with new technologies. Functional foods and nutraceuticals and methods of food fortification. Enzymes and their application in food industry. Principles of food biotechnology, advances in fermentation technology, genetic modification of microorganisms in food industry (lactic acid bacteria, yeasts and moulds). Production of

high valued food products viz., enzymes, organic acids, SCP, nutritional additives, flavours, pigments. Development of new products and value addition.

Suggested Reading

1. Barbosa-Canovas. (2002). *Novel food processing technologies*. CRC. Press
2. Bhutani, R. C., (2003). *Fruits and vegetables preservation*. Biotech Books, Delhi.
3. Da-Wen Sun. (2006). *Thermal food processing: new technologies and quality issues*. CRC/Taylor and Francis.
4. Gould, G. W. (2000). *New methods of food preservation*. CRC. Springer Science.
5. Philip R., (2001). *Thermal technologies in food processing*. CRC Press.
6. Ramaswamy, H. and Marcotte, M., (2006). *Food Processing: Principles and applications*. Taylor and Francis.
7. Rajarathnam, S. and Ramteke, R. S. (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA pub.

21HO3295 ADVANCES IN LABORATORY TECHNIQUES IN POST-HARVEST TECHNOLOGY

Credits: 3 (3+0)

Course Objectives:

To impart basic knowledge on

1. Principles of food quality assurance
2. Food laws and food standards
3. Advanced techniques of food analysis

Course Outcomes:

At the end of this course, the students will be able to

1. Explain the techniques for food analysis
2. Differentiate the browning reactions from non-browning reaction
3. Analyze the different kinds of food additives
4. Demonstrate the non-destructive quality evaluation of food
5. Analyze the food through different types of Chromatographic techniques
6. Elucidate the residual analysis of food

Theory

Importance of quality of processed foods. Principles of food quality assurance. Introduction to quality evaluation. Food grades, standards, laws and regulations. Sampling procedure for food analysis. Advances in techniques of food analysis for carbohydrates, organic acids, vitamins, polyphenols, flavonoids, minerals, anthocyanins, enzymes; Rheological techniques and instrumentation used in food industry. Determination of browning and associated reactions in processed foods and their implications. Analysis of food additives like food colour, antioxidants, emulsifier, etc. Analysis of pesticide residues, metallic contaminants, aflatoxin. Analysis of food flavours. Quality analysis of processed fruits and vegetables, coffee, tea and spices. Identification and enumeration of microbial contaminants. Principles of chromatography (GC, GCMS, HPLC, LCMS), spectrophotometry (Atomic absorption spectrophotometer, ICAP spectrophotometer), ICP-MS, ICPOES, NMR, ESR, amino acid analyser, flame photometry, electrophoresis, colour measurement in foods, IRGA, radioisotopic techniques. Nondestructive quality evaluation (NDQE)- E-nose E-tongue, machine vision. Electrophoresis. Sample preparation for quality analysis. Energy calculation, sample calculations. Texture analysis. Rheology of different foods. Instrumental colour analysis. Sensory evaluation and microbiological examinations of fresh and processed products; Estimation of tannin/phytic acid by spectrometric method; moisture and fat analysis by NIR spectroscopy; Separation and identification of sugars in fruit juices; Separation and identification of carotenoids by column chromatography; Estimation of respiration in fruits and vegetables, flavor profile in essential oils using GC; Identification and determination of organic acids by HPLC; capsaicin content and Scoville Heat Units in chillies; Heavy metal analysis using atomic absorption spectrometry; Residue analysis.

Suggested Reading

1. AOAC International. (2003). *Official methods of analysis of AOAC International*. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities. AVI Publ.
2. Leenheer, A. P., Lambert, W. E. and Bocxlaer, J. F., (2000). *Modern chromatographic analysis of vitamins*. 3rd Ed. Marcel Dekker.
3. Maslowitz, H. (2000). *Applied sensory analysis of food*. Vol. I & II. CRC Press.
4. Ranganna, S. (2001). *Handbook of analysis and quality control for fruit and vegetable products*. 2nd Ed. Tata-McGraw-Hill.
5. Taylor, A. (2002). *Food flavour technology*. Sheffield Academic Press.

6. Rajarathnam, S. and Ramteke, R. S. (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA pub.

21HO3296 MANAGEMENT OF STORAGE AND SUPPLY/COLD CHAIN TECHNIQUES OF HORTICULTURAL PRODUCE

Credits: 3 (3+0)

Course Objectives:

To impart basic knowledge on

1. Modern methods of storage of horticulture produce
2. Functional food and nutraceuticals
3. Advanced supply chain management of horticulture produce

Course Outcomes:

At the end of this course, the students will be able to

1. Apply cold chain technology to enhance the shelf life of horticultural produce
2. Enumerate the role of modern methods of food storage
3. Explain the importance of supply chain management of food
4. Enumerate the importance of e-marketing strategies of horticultural produce
5. Develop innovative and low-cost methods for storage of food
6. Demonstrate various models in decision making

Theory

Controlled atmosphere, modified atmosphere, hypobaric storage, cold storage. Building blocks of supply chain network, performance measures, decisions in supply world and models. Supply chain inventory management. Use of stochastic models and combinatorial optimization in supply chain planning, layout, capacity planning, inventory optimization, dynamic routing and scheduling. Internet technologies and electronic commerce in supply chain management related to enterprise resource planning, Q procurement, logistics, internet auctions, e-market and business process optimization. Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration. Products going in cold chain, their temperature and humidity requirements, packaging needs and their compatibility in cold chain. Stages and points of control in cold storages and structures, functions in cold storages, pallet layout and stacking options, flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems. Temperature recording devices used during transport, documentation and traceability, risk management problem diagnosis, cost benefit studies for type of transport, loading and unloading, storage duration.

Suggested Reading

1. Chattopadhyaya, S. K. (2007). *Handling, transportation and storage of fruits and vegetables*. Gene-Tech books, New Delhi.
2. Chopra, S. and Meindel, P. (2002). *Supply chain management: Strategy, planning and operation*. Prentice Hall.
3. Levi, D. S., Kaminsky, P. and Levi, E. S., (2000). *Designing and managing the supply chain: Concepts, strategies and case studies*. Mc Graw Hill.
4. Shapiro, J. F. (2001). *Modeling the supply chain*. Duxbury Thomson Learning.
5. Viswanadham, N. (2000). *Analysis of manufacturing enterprises*. Kluwer.
6. Rajarathnam, S. and Ramteke, R. S., (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA pub.

21HO3297 ADVANCES IN THE PHYSIOLOGY OF RIPENING AND SENESCENCE

Credits: 2 (2+0)

Course Objectives:

To impart basic knowledge on

1. Environmental control the ripening and senescence
2. Molecular and physiological mechanisms of senescence and ripening
3. Methods to manipulate ethylene biosynthetic pathway

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the internal factor and external factors that cause senescence and ripening
2. Elucidate the molecular mechanism of senescence and ripening
3. Enumerate the structural changes of cell during senescence and ripening

4. Describe the biosynthetic pathway of ethylene
5. Explain the physiological and biochemical changes take place during senescence and ripening
6. Describe the involvement of many types of enzymes during ripening of fruits

Theory

Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening. Estimation of ethylene during ripening and senescence, determination of reactive oxygen species and scavenging enzymes, measurement of dark and alternate respiration rates during ripening and senescence. Estimation of ripening related enzyme activity, cellulases, pectin methyl esterases, polygalacturonase, regulation of ripening etc. Senescence associated genes. Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening. Ethylene biosynthesis, perception and molecular mechanism of action; regulatory role of ethylene in senescence and ripening. Approaches to manipulate ethylene biosynthesis and action. Alternate postharvest methodology and quality attributes. Scope for genetic modification of post-harvest life of horticultural crops.

Suggested Reading

1. Knee, M. (2002). *Fruit quality and its biological basis*. Sheffield Academic Press, CRC Press.
2. Khan, N. A., (2006). *Ethylene action in plants*. Springer Verlag.
3. Bartz, J. A. and Brecht, J. K. (2003). *Post-harvest physiology and pathology of vegetables*. Marcel Dekker Inc.
4. Valpuesta, V. (2002). *Fruit and vegetable biotechnology*. Woodhead Publishing Limited, Cambridge, England.
5. Paliyath, G., Murr, D. P., Handa, A. K., Andlurie, S. (2008). *Post-harvest biology and technology of fruits, vegetables and flowers*. Blackwell Publishing, Iowa, UAS.
6. Nooden, L. D., (2004). *Plant cell death processes*. Elsevier Science, E Sevier Academic Press
7. Pajarathnam, S and Ramteke, R. S., (2001). *Advances in preservation and processing technology of fruits and vegetables*. By N, PA pub
8. Suresh Kumar, P., Sagar, V. R. and Manish, K., (2009). *Post-harvest physiology and quality management of fruits and vegetables*. ATPA pub. ISBN

21HO3298 MANAGEMENT OF BIOTIC AND ABIOTIC STRESS IN HORTICULTURAL CROPS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Classification of stress and its impacts
2. Crop modelling for stress situations
3. Techniques involved in the stress management

Course Outcomes:

At the end of this course, the students will be able to

1. Summarize the classification of stress
2. Discuss the metabolic changes induced by stress factors
3. Enumerate the crop modelling for stress situations
4. Describe the methods of stress management in fruit crops
5. Discuss on the water use efficiency
6. Elucidate the crop growth sustainability indices

Theory

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution - increased level of CO₂, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Crop modelling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti-transpirants and PGRs in stress management, modeo-faction and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Suggested Reading

1. Blumm, A. (1988). *Plant breeding for stress environments*. CRC.

2. Christiansen, M. N. and Lewis, C. F. (1982). *Breeding plants for less favourable environments*. Wiley Inter. Science.
3. Gupta, U. S. (1990). *Physiological aspects of dry farming*.
4. Hsiao, T. C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiology* 24:519-570.
5. Kramer, P. J. (1980). Drought stress and the origin of adaptation. In: *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.
6. Levitt, J. (1972). *Response of plants to environmental stresses*. Academic Press.
7. Maloo, S. R. (2003). *Abiotic stress and crop productivity*. Agrotech Publ. Academy.
8. Mussell, H. and Staples, R. (1979). *Stress physiology in crop plants*. Wiley Inter. Science.
9. Nickell, L. G. (1983). *Plant growth regulating Chemicals*. CRC.
10. Peter, K. V. (Ed.). (2008). *Basics of horticulture*. New India Publ. Agency.
11. Turener, N. C. and Kramer, P. J. (1980). *Adaptation of plants to water and high temperature stress*. John Wiley & Sons.

21HO3299 INNOVATIVE PACKAGING TECHNOLOGY FOR HORTICULTURAL PRODUCE

Credits: 2(2+0)

Course Objectives:

To impart basic knowledge on

1. Advanced methods of packaging of horticultural produce
2. Role of different packaging materials
3. Recycling of packaging materials

Course Outcomes:

At the end of this course, the students will be able to

1. Apply advanced packaging technology for better quality of the horticulture produce
2. Enumerate the advantages of NMBP over to the conventional packaging materials
3. Describe the packaging and flavor interaction
4. Enumerate the time temperature indicators and maximizing its effectiveness
5. Design the packaging materials for predicting shelf life of horticultural produce
6. Evaluate the pesticide migration from packaging material to food

Theory

Active packaging techniques, intelligent packaging techniques, novel packaging techniques, oxygen scavenging technology, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging: Development of antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging. Non-Migratory Bioactive Polymers (NMBP) in food packaging, advantages of NMBP, limitations, inherently bioactive synthetic polymers: types and applications. Polymers with immobilized bioactive compounds. Time-temperature indicators (TTIs), Defining and classifying TTIs, Requirements for TTIs. The development of TTIs, Current TTI systems, maximizing the effectiveness of TTIs, using TTIs to monitor shelf-life during distribution, Using TTIs to optimize distribution and stock rotation. Packaging-Flavour interactions, factors affecting flavor absorption, role of the food matrix, role of differing packaging materials, Case study: Packaging and lipid oxidation, Modeling flavour absorption, Packaging-Flavour interactions and active packaging, Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O₂ MAP. Recycling of packaging materials

Suggested Reading

1. Ahvenainen, R. (2001). *Novel food packaging techniques*. CRC.
2. Rajarathnam, S. and Ramteke, R. S. (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA pub

21AG3229 SIMULATION TECHNIQUES

Credits: 2 (1 + 1)

Course Objectives:

To impart knowledge on

1. Simulation methods for various probability models
2. Randomization analysis through various computer software packages
3. Stochastic simulation

Course Outcomes:

On completion of this course, students will be able to

1. Implement simulation methods for various probability models.
2. Execute resampling methods
3. Simulate multivariate distributions
4. Analyze simulated datasets using popular computer software packages
5. Do Markov Chain analysis
6. Evaluate Reversible jump-MCMC

Theory

Review of simulation methods; Implementation of simulation methods – for various probability models, and resampling methods: theory and application of the jackknife and the bootstrap. Randomization tests, analysis using computer software packages. Simulating multivariate distributions, MCMC methods and Gibbs sampler. Correlograms, periodograms, fast Fourier transforms, power spectra, cross spectra, coherences, ARMA and transfer-function models, spectral-domain regression. Simulated data sets to be analyzed using popular computer software packages. Stochastic simulation: Markov Chain, Monte Carlo, Gibbs' sampling, Hastings-Metropolis algorithms, critical slowing-down and remedies, auxiliary variables, simulated tempering, reversible- jump MCMC and multi-grid methods.

Practical

Simulation from various probability models; Resampling methods, jack knife and the bootstrap; Randomization tests; Simulating multivariate distributions, MCMC methods and Gibbs sampler; Correlograms, periodograms, fast Fourier transforms, power spectra, cross-spectra, coherences; ARMA and transfer-function models, spectral-domain regression; Simulated data sets to be analyzed using popular computer software packages; Markov Chain, Monte Carlo, Gibbs' sampling; Reversible- jump MCMC and multi-grid methods.

Reference:

1. Averill, M.L and Kelton, D. (2005). *Simulation, Modeling and Analysis*. Tata McGraw Hill.
2. Balakrishnan, N., Melas, V.B and Ermakov, S. (2000). *Advances in Stochastic Simulation Methods*. Basel-Birkhauser.
3. Banks, J. (1998). *Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice*. John Wiley.
4. Bratley, P., Fox, B.L and Schrage, L.E. (1987). *A Guide to Simulation*. Springer.
5. Davison, A.C and Hinkley, D.V. (2003). *Bootstrap Methods and their Application*. Cambridge University Press.
6. Gamerman, D., Lopes, H.F and Lopes, H.F. (2006). *Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference*. CRC Press.
7. Gardner, F.M and Baker, J.D. (1997). *Simulation Techniques Set*. John Wiley.
8. Gentle, J.E. (2005). *Random Number Generation and Monte Carlo Methods*. Springer.
9. Janacek, G and Louise, S. (1993). *Time Series: Forecasting, Simulation, Applications*. Ellis Horwood Series in Mathematics and Its Applications.
10. Kleijnen, J and Groenendaal, W.V. (1992). *Simulation: A Statistical Perspective*. John Wiley.
11. Kleijnen, J. (1974) (Part I), 1975 (Part II). *Statistical Techniques in Simulation*. Marcel Dekker.
12. Law, A and Kelton, D. (2000). *Simulation Modeling and Analysis*. McGrawHill.
13. Press, W.H., Flannery, B.P., Teukolsky, S.A and Vetterling, W.T. (1986). *Numerical Recipes*. Cambridge University Press.
14. Ripley, B.D. (1987). *Stochastic Simulation*. John Wiley.
15. Ross, S.M. (1997). *Simulation*. John Wiley.

21AG3230 SAMPLE SURVEYS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Basic concepts in sampling
2. Sampling errors and calculation of bias
3. Preparation of schedule and questionnaire

Course Outcomes:

On completion of this course, students will be able to

1. Sample units of different types and sizes
2. Estimate the sampling errors
3. Find out the non-sampling errors

4. Rectify the bias in sample selection and estimation
5. Prepare the sampling schedule and questionnaire
6. Conduct two stage sampling

Theory:

Basic concepts in sampling, complete enumeration v/s sampling, field of enquiry, frames suitable for various types of surveys, elementary units, sample units of different types and sizes, selection of samples, bias in selection and estimation, sampling errors of estimates and their estimation. Simple random sampling, stratified sampling, ratio and regression estimates, systematic sampling, two stage and cluster sampling, preparation of schedule and questionnaire. Methods of enquiry, elementary idea about non-sampling errors.

Practical:

Use of random number tables and selection of random samples by different methods, Estimation of mean, variance and standard error using SRSWR., Estimation of mean, variance and standard error using SRSWOR. Its efficiency over S.R.S.W.R. Stratified sampling, allocation of sample size to different strata under different allocation procedures. Estimation of mean and variance in case of stratified sampling (Proportionate allocation) its efficiency over S.R.S.W.O.R. Neyman allocation in stratified sampling and its efficiency over S.R.S.W.O.R. Systematic sampling, estimation of mean and variance. Circular systematic sampling, estimation of mean and variance. Cluster sampling, estimation of mean and variance. Ratio method of estimation, calculation of bias. MSE and efficiency compared to S.R.S.W.O.R. Two stage sampling with equal number of units in each P.S.U.

Reference:

1. Sukhatme, P.V., Sukhatme, B.V and Ashok, C. (1984). Sampling Theory and Survey with Applications. IASRI, New Delhi.
2. Cochran, W.G. (1953). Sampling Techniques. Asia Publishing House, New Delhi.
3. Raj, D. (1968). Sampling Theory. Tata McGraw-Hill Publishing Company, Bombay.
4. Murthy, M.N. (1967). Sampling Theory and Methods. Statistical Publishing Society, Calcutta

21AG3231 WEATHER FORECASTING

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Importance and scope of weather forecasting system
2. Approaches and methods of weather forecast
3. Weather based advisories and modification of weather hazards

Course Outcomes:

On completion of this course, students will be able to

1. Understand the scope of weather forecasting system
2. Forecast weather through synoptic, statistical and numerical prediction method
3. Apply indigenous technical knowledge base signals in weather forecast
4. Interpret weather forecasts for soil moisture, farm operations and epidemics
5. Formulate Special weather forecast for natural calamities
6. Modifications of weather hazards through scientific methods

Theory

Weather forecasting system: definition, scope and importance; types of forecasting: short, medium and long-range; study of synoptic charts with special reference to location of highs and lows, jet streams, synoptic features and weather anomalies and zones of thermal advection and interpretation of satellite pictures of clouds in visible and infra-red range; weather forecasting network. Approaches for weather forecasts: methods of weather forecasts - synoptic, numerical prediction, statistical, analogue, persistence and climatological approach, nano-technological approach, Indigenous Technical Knowledge (ITK) base-signals from flora, fauna, insects, birds, animals' behavior; various methods of verification of location-specific weather forecast.

Weather based advisories: interpretation of weather forecasts for soil moisture, farm operations, pest and disease development and epidemics, crops and livestock production; preparation of weather-based advisories and dissemination. Special forecasts: special forecasts for natural calamities such as drought, floods, high winds, cold (frost) and heat waves, hailstorms, cyclones and protection measures against such hazards. Modification of weather hazards: weather modification for agriculture; scientific advances in

artificial rain making, hail suppression, dissipation of fog and stratus clouds, modification of severe storms and electric behavior of clouds.

Practical

Exercise on weather forecasting for various applications. Preparation of weather-based agro-advisories based on weather forecast using various approaches and synoptic charts.

Reference:

1. Watts, A. (2005). *Instant Weather Forecasting*. Water Craft Books.
2. Ram Sastry, A. A. (1984). *Weather and Weather Forecasting*. Publication Division, GOI, New Delhi.
3. Singh, S.V., Rathore, L.S and Trivedi, H.K.N. (1999). *A Guide for Agrometeorological Advisory Services. Department of Science & Technology*. NCMRWF, New Delhi.
4. Wegman and Depriest (1980). *Statistical Analysis of Weather Modification Experiments*. Amazon Book Company.

21AG3234 ADVANCES IN SEED SCIENCE RESEARCH

Credits: 1(1+0)

Course Objectives:

To impart knowledge on

1. Advances in various aspects of seed science
2. Advanced application aspects in seed research
3. Modern techniques to identify varieties and hybrids

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the physiological and molecular aspects of seed development
2. Enumerate the seed dormancy using mathematical models
3. Identify the structural changes in the developing seeds
4. Discuss on the recent accomplishments in seed research
5. Elucidate on the modern techniques available for improving the seed quality
6. Discuss on the detection and identification of seed borne diseases

Theory

Physiological and molecular aspects of seed development and control of germination and dormancy; gene expression during seed development; desiccation and stress tolerance and conservation; prediction of seed dormancy and longevity using mathematical models; structural changes in membranes of developing seeds during acquisition of desiccation tolerance; dehydration damage and repair in imbibed seeds, seed biotechnology; genetic analysis and QTL mapping of germination traits; seed ageing and ethylene production; recent accomplishments in seed enhancement research and application of nanotechnology. Modern techniques for identification of varieties and hybrids; principles and procedures of electrophoresis, machine vision technique, DNA finger printing and other molecular techniques and their utilization; techniques for improving seed quality; proteomic analysis; seed priming, coating, pelleting and synthetic seeds; GM seeds and their detection, terminator technology (GURT). Detection and identification of seed borne fungi, bacteria, viruses, nematodes and insect pests through advanced techniques like ELISA, PCR based techniques etc. Seed production of self-incompatible and apomictic plant species; recent developments in seed laws, policies and seed certification system in India and its comparison with OECD seed certification schemes; IPR systems and PVP internationally.

Reference:

1. Bench, A.L.R and Sanchez, R.A. (2004). *Handbook of Seed Physiology*. Food Product Press.
2. Black, M and Bewley, J.D. (Eds.). (2000). *Seed Technology and its Biological Basis*. Sheffield Academic Press.
3. Nicolas, G., Bradford, K.J., Come, D and Pritchard, H.W. 2003. *The Biology of Seeds, Recent Research Advances*. CABI.

**DEPARTMENT OF
AGRICULTURE**

LIST OF NEW COURSES

S.No	Discipline	Course Code	Name of the Course	Credits
1	AGR	21AG1001	Fundamentals of Agronomy	4(3+1)
2	AGR	21AG1002	Agricultural Heritage*	1(1+0)*
3	AGR	21AG1003	Introduction to Forestry	2(1+1)
4	AEC	21AG1051	Fundamentals of Agricultural Economics	2(2+0)
5	AEX	21AG1101	Communication Skills and Personality Development	2(1+1)
6	AEN	21AG1151	Fundamentals of Entomology	4(3+1)
7	GPB	21AG1201	Fundamentals of Genetics	3(2+1)
8	SAC	21AG1301	Fundamentals of Soil Science	3(2+1)
9	AGR	21AG1302	Introductory Agro-meteorology & Climate Change	2(1+1)
10	SAC	21AG1303	Agricultural Microbiology	2(1+1)
11	PAT	21AG1351	Fundamentals of Plant Pathology	4(3+1)
12	AEG	21AG1451	Introductory Soil and Water Conservation Engineering	2(1+1)
13	BTH	21AG1501	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
14	BTH	21AG1503	Fundamentals of Crop Physiology	2(1+1)
15	AGR	21AG2004	Crop Production Technology – I (<i>Kharif Crops</i>)	2(1+1)
16	AGR	21AG2005	Crop Production Technology –II (<i>Rabi Crops</i>)	2(1+1)
17	AGR	21AG2006	Farming System & Sustainable Agriculture	1(1+0)
18	AGR	21AG2007	Practical Crop Production – I (<i>Kharif crops</i>)	2(0+2)
19	AGR	21AG2008	Geoinformatics and Nano-technology and Precision Farming	2(1+1)
20	AGR	21AG2009	Rainfed Agriculture & Watershed Management	2(1+1)
21	AGR	21AG2010	Practical Crop Production –II (<i>Rabi crops</i>)	2(0+2)
22	AGR	21AG2011	Principles of Organic Farming	2(1+1)
23	AEC	21AG2052	Agricultural Finance and Cooperation	3(2+1)
24	AEC	21AG2053	Agricultural Marketing Trade & Prices	3(2+1)
25	AEC	21AG2054	Entrepreneurship Development and Business Communication	2(1+1)
26	AEC	21AG2055	Farm Management, Production & Resource Economics	2(1+1)
27	AEX	21AG2102	Rural Sociology & Educational Psychology	2(2+0)
28	AEX	21AG2103	Fundamentals of Agricultural Extension Education	3(2+1)
29	AEX	21AG2104	Educational Tour-I	1(0+1)
30	AEX	21AG2105	Educational Tour-II	1(0+1)
31	AEX	21AG2106	Rural Agricultural Work Experience (RAWE) and Agro-Industrial Attachment (AIA)	20(0+20)
32	AEX	21AG2107	Experiential Learning Program (ELP) (Module I and II)	20(0+20)
33	AEN	21AG2152	Pests of Crops and Stored Grain and their Management	3(2+1)
34	AEN	21AG2153	Management of Beneficial Insects	2(1+1)
35	GPB	21AG2202	Fundamentals of Plant Breeding	3(2+1)
36	GPB	21AG2203	Principles of Seed Technology	3(1+2)
37	GPB	21AG2204	Crop Improvement-I (<i>Kharif Crops</i>)	2(1+1)
38	GPB	21AG2205	Crop Improvement-II (<i>Rabi crops</i>)	2(1+1)
39	SAC	21AG2304	Environmental Studies and Disaster Management	3(2+1)
40	AEG	21AG2305	Renewable Energy and Green Technology	2(1+1)
41	SAC	21AG2306	Manures, Fertilizers and Soil Fertility Management	3(2+1)
42	SAC	21AG2307	Problematic Soils and their Management	2(2+0)
43	PAT	21AG2352	Diseases of Field and Horticultural Crops and their Management - I	3(2+1)
44	PAT	21AG2353	Diseases of Field and Horticultural Crops and their management-II	3(2+1)
45	PAT	21AG2354	Principles of Integrated Pest and Disease Management	3(2+1)
46	ANS	21AG2401	Livestock and Poultry Management	4(3+1)
47	AEG	21AG2452	Farm Machinery and Power	2(1+1)
48	AEG	21AG2453	Protected Cultivation and Secondary Agriculture	2(1+1)
49	AEC	21AG2551	Agri- Informatics	2(1+1)

50	AEC	21AG2552	Intellectual Property Rights	1(1+0)
51	AGR	21HO1001	Agro-meteorology and Climate Change	2(1+1)
52	AEC	21HO1051	Economics and Marketing	3(2+1)
53	AEN	21HO1151	Fundamentals of Entomology	3 (2+1)
54	GPB	21HO1201	Principles of Genetics and Cytogenetics	3(2+1)
55	GPB	21HO1202	Principles of Plant Breeding	3(2+1)
56	HOR	21HO1251	Fundamentals of Horticulture	3(2+1)
57	HOR	21HO1252	Principles of Landscape Architecture	2(1+1)
58	HOR	21HO1253	Plant Propagation and Nursery Management	2(1+1)
59	HOR	21HO1254	Tropical and Subtropical Fruits	3(2+1)
60	HOR	21HO1255	Tropical and Subtropical Vegetables	3(2+1)
61	HOR	21HO1270	Production Technology for Fruit and Plantation Crops	2(1+1)
62	SAC	21HO1301	Introductory Microbiology	2(1+1)
63	SAC	21HO1302	Fundamentals of Soil Science	2(1+1)
64	PAT	21HO1351	Fundamentals of Plant Pathology	3(2+1)
65	BTH	21HO1501	Elementary Plant Biochemistry	2(1+1)
66	BTH	21HO1502	Introductory Crop Physiology	2(1+1)
67	HOR	21HO1503	Growth and Development of Horticultural Crops	2(1+1)
68	AGR	21HO2002	Introduction to Major Field Crops	2(1+1)
69	AGR	21HO2003	Introductory Agroforestry	2(1+1)
70	HOR	21HO2004	Weed Management in Horticultural Crops	2(1+1)
71	AGR	21HO2005	Organic Farming	3(2+1)
72	HOR	21HO2052	Horti-Business Management	2(2+0)
73	AEX	21HO2101	Study Tour-I	1(0+1)
74	AEX	21HO2102	Fundamentals of Extension Education	2(1+1)
75	AEX	21HO2103	Study tour – II	1(0+1)
76	AEX	21HO2104	Rural Horticultural Work Experience (RHWE)	20(0+20)
77	AEN	21HO2152	Nematode Pests of Horticultural Crops and their Management	2(1+1)
78	AEN	21HO2153	Insect Pests of Vegetable, Ornamental and Spice Crops	3(2+1)
79	AEN	21HO2154	Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops	3(2+1)
80	AEN	21HO2155	Apiculture, Sericulture and Lac Culture	2(1+1)
81	GPB	21HO2203	Breeding of Fruit and Plantation Crops	3(2+1)
82	GPB	21HO2204	Breeding of Vegetable, Tuber and Spice Crops	3(2+1)
83	GPB	21HO2205	Breeding and Seed Production of Flower and Ornamental Plants	3(2+1)
84	HOR	21HO2206	Seed production of Vegetable, Tuber and Spice Crops	3(2+1)
85	HOR	21HO2256	Commercial Floriculture	3(2+1)
86	HOR	21HO2257	Fundamentals of Food Technology	2(1+1)
87	HOR	21HO2258	Temperate Vegetable Crops	2(1+1)
88	HOR	21HO2259	Temperate Fruit Crops	2(1+1)
89	HOR	21HO2260	Spices and Condiments	3(2+1)
90	HOR	21HO2261	Ornamental Horticulture	2(1+1)
91	HOR	21HO2262	Plantation Crops	3(2+1)
92	HOR	21HO2263	Medicinal and Aromatic crops	3(2+1)
93	HOR	21HO2264	Dry land Horticulture	2(1+1)
94	HOR	21HO2265	Potato and tuber crops	2(1+1)
95	HOR	21HO2266	Orchard and Estate Management	2(1+1)
96	AGR	21HO2267	Precision Farming and Protected Cultivation	3(2+1)
97	HOR	21HO2268	Postharvest Management of Horticultural Crops	3(2+1)
98	HOR	21HO2269	Processing of Horticultural Crops	3(1+2)
99	HOR	21HO2271	Production Technology for Vegetables and Spices	2(1+1)
100	HOR	21HO2272	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
101	HOR	21HO2273	Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)

102	HOR	21HO2274	Principles of Food Science and Nutrition	2(2+0)
103	SAC	21HO2305	Soil, Water and Plant Analysis	2(1+1)
104	SAC	21HO2306	Soil Fertility and Nutrient Management	2(1+1)
105	PAT	21HO2352	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	3(2+1)
106	PAT	21HO2353	Diseases of Vegetable, Ornamental and Spice Crops	3(2+1)
107	HOR	21HO2452	Water Management in Horticultural Crops	2(1+1)
108	BTH	21HO2504	Elementary Plant Biotechnology	2(1+1)
109	AGR	21AG3001	Modern Concepts in Crop Production	2(2+0)
110	AGR	21AG3002	Principles and Practices of Soil Fertility and Nutrient Management	3(2+1)
111	AGR	21AG3003	Principles and Practices of Weed Management	3(2+1)
112	AGR	21AG3004	Principles and Practices of Water Management	3(2+1)
113	AGR	21AG3005	Agro-Meteorology and Crop Weather Forecasting	3(2+1)
114	AGR	21AG3006	Cropping Systems and Sustainable Agriculture	3(2+1)
115	AGR	21AG3007	Dryland Farming and Watershed Management	3(2+1)
116	AGR	21AG3008	Agronomy of Major Cereals and Pulses	3(2+1)
117	AGR	21AG3009	Agronomy of Oilseed, Fiber and Sugar crops	3(2+1)
118	AGR	21AG3010	Agronomy of Fodder and Forage Crops	3(2+1)
119	AGR	21AG3011	Agrostology and Agroforestry	3(2+1)
120	AGR	21AG3012	Principles and Practices of Organic Farming	3(2+1)
121	AGR	21AG3013	Masters Seminar	1(1+0)
122	AGR	21AG3014	Masters Research	30(0+30)
123	AGR	21AG3015	Current Trends in Agronomy	3(3+0)
124	AGR	21AG3016	Crop Ecology	2(2+0)
125	AGR	21AG3017	Irrigation Management	3(2+1)
126	AGR	21AG3018	Advances in Weed management	2(2+0)
127	AGR	21AG3019	Integrated Farming Systems for Sustainable Agriculture	2(2+0)
128	AGR	21AG3020	Soil Conservation and Watershed Management	3(2+1)
129	AGR	21AG3021	Stress Crop Production	3(2+1)
130	AGR	21AG3022	Doctoral Seminar I	1(1+0)
131	AGR	21AG3023	Doctoral Seminar II	1(1+0)
132	AGR	21AG3024	Doctoral Research	75(0+75)
133	GPB	21AG3025	Principles of Genetics	3(2+1)
134	GPB	21AG3026	Principles of Cytogenetics	3(2+1)
135	GPB	21AG3027	Principles of Plant Breeding	3(2+1)
136	GPB	21AG3028	Principles of Quantitative Genetics	3(2+1)
137	GPB	21AG3029	Mutagenesis and Mutation Breeding	3(2+1)
138	GPB	21AG3030	Population Genetics	2(1+1)
139	GPB	21AG3031	Heterosis Breeding	2(1+1)
140	GPB	21AG3032	Cell Biology and Molecular Genetics	3(2+1)
141	GPB	21AG3033	Biotechnology for Crop Improvement	3(2+1)
142	GPB	21AG3034	Breeding for quality traits	2(1+1)
143	GPB	21AG3035	Gene regulation and Expression	2(2+0)
144	GPB	21AG3036	Masters Seminar	1(1+0)
145	GPB	21AG3037	Masters Research	30(0+30)
146	GPB	21AG3038	Plant Genetic Resources and Their Utilization	2(2+0)
147	GPB	21AG3039	Advances in Quantitative Genetics	3(2+1)
148	GPB	21AG3040	Genomics in Crop Improvement	3(2+1)
149	GPB	21AG3041	Cellular and Chromosomal Manipulations in Crop Improvement	2(2+0)
150	GPB	21AG3042	Advanced Plant Breeding Systems	2(2+0)
151	GPB	21AG3043	Crop Evolution	3(2+1)
152	GPB	21AG3044	Breeding Designer Crops	3(2+1)
153	GPB	21AG3045	Advances in Breeding of Major Field Crops	3(3+0)
154	GPB	21AG3046	Doctoral Seminar I	1(1+0)
155	GPB	21AG3047	Doctoral Seminar II	1(1+0)

156	GPB	21AG3048	Doctoral Research	75(0+75)
157	AEN	21AG3090	Advanced Insect Systematics	3(1+2)
158	AEN	21AG3091	Advanced Insect Physiology	2(2+0)
159	AEN	21AG3092	Advanced Insecticide Toxicology	3(2+1)
160	AEN	21AG3093	Molecular Approaches in Entomological Research	2(1+1)
161	AEN	21AG3094	Advanced Integrated Pest Management	2(2+0)
162	AEN	21AG3095	Insect Behaviour	2(1+1)
163	AEN	21AG3096	Recent Trends in Biological Control	2(1+1)
164	AEN	21AG3097	Advanced Host Plant Resistance	2(1+1)
165	AEN	21AG3098	Advanced Acarology	2(1+1)
166	AEN	21AG3099	Doctoral Seminar I	1(1+0)
167	AEN	21AG3100	Doctoral Seminar II	1(1+0)
168	AEN	21AG3101	Doctoral Research	75(0+75)
169	PAT	21AG3117	Advanced Mycology	3(2+1)
170	PAT	21AG3118	Advanced Virology	3(2+1)
171	PAT	21AG3119	Advanced Bacteriology	3(2+1)
172	PAT	21AG3120	Molecular Basis of Host Pathogen Interaction	3(2+1)
173	PAT	21AG3121	Principles and Procedures of Certification	1(1+0)
174	PAT	21AG3122	Plant Biosecurity and Biosafety	2(2+0)
175	PAT	21AG3123	Advances in Nematode Management	3(2+1)
176	PAT	21AG3124	Doctoral Seminar I	1(1+0)
177	PAT	21AG3125	Doctoral Seminar II	1(1+0)
178	PAT	21AG3126	Doctoral Research	75(0+75)
179	FSC	21HO3127	Growth and Development of Horticultural Crops	3(2+1)
180	FSC	21HO3128	Tropical and Dry Land Fruit Production	3(2+1)
181	FSC	21HO3129	Biodiversity and Conservation of Fruit Crops	3(2+1)
182	FSC	21HO3130	Propagation and Nursery Management of Fruit Crops	3(2+1)
183	FSC	21HO3131	Subtropical and Temperate Fruit Production	3(2+1)
184	FSC	21HO3132	Canopy Management in Fruit Crops	2(1+1)
185	FSC	21HO3133	Breeding of Fruit Crops	3(2+1)
186	FSC	21HO3134	Masters Seminar	1(1+0)
187	FSC	21HO3135	Masters Research	30(0+30)
188	FSC	21HO3136	Advances in Production of Fruit crops	3(2+1)
189	FSC	21HO3137	Advances in Growth Regulation of fruit crops	3(2+1)
190	FSC	21HO3138	Advances in Breeding of Fruit crops	3(2+1)
191	FSC	21HO3139	Genomics and Bioinformatics in Horticulture	3(2+1)
192	FSC	21HO3140	Biotic and Abiotic Stress management in Horticultural crops	3(2+1)
193	FSC	21HO3141	Environmental Horticulture	3(2+1)
194	FSC	21HO3142	Doctoral Seminar I	1(1+0)
195	FSC	21HO3143	Doctoral Seminar II	1(1+0)
196	FSC	21HO3144	Doctoral Research	75(0+75)
197	VEG	21HO3154	Advances in Vegetable Production	3(2+1)
198	VEG	21HO3155	Advances in Breeding of Vegetable Crops	3(2+1)
199	VEG	21HO3156	Protected Cultivation of Vegetable Crops	2(1+1)
200	VEG	21HO3157	Biotechnology in Vegetable Crops	3(2+1)
201	VEG	21HO3158	Seed Certification, Processing and Storage of Vegetable crops	2(1+1)
202	VEG	21HO3159	Doctoral Seminar I	1(1+0)
203	VEG	21HO3160	Doctoral Seminar II	1(1+0)
204	VEG	21HO3161	Doctoral Research	75(0+75)
205	FLA	21HO3171	Advances in Flower Production Technology	3(2+1)
206	FLA	21HO3172	Advances in Protected and Precision Floriculture	2(1+1)
207	FLA	21HO3173	Advances in Breeding of Flower Crops	3(2+1)
208	FLA	21HO3174	Advances in Landscape Architecture	3(1+2)
209	FLA	21HO3175	Advances in Biochemistry and Biotechnology of Flowers	3(2+1)
210	FLA	21HO3176	Doctoral Seminar I	1(1+0)

211	FLA	21HO3177	Doctoral Seminar II	1(1+0)
212	FLA	21HO3178	Doctoral Research	75(0+75)
213	PSM	21HO3188	Advances in Production of Plantation Crops	3(2+1)
214	PSM	21HO3189	Advances in Spice Production	3(2+1)
215	PSM	21HO3190	Advances in Medicinal and Aromatic Crop Production Technology	3(2+1)
216	PSM	21HO3191	Advances in Breeding of Plantation Crops and Spices	3(2+1)
217	PSM	21HO3192	Advances in Breeding of Medicinal and Aromatic crops	3(2+1)
218	PSM	21HO3193	Doctoral Seminar I	1(1+0)
219	PSM	21HO3194	Doctoral seminar II	1(1+0)
220	PSM	21HO3195	Doctoral Research	75(0+75)
221	PHT	21HO3206	Physiology of Ripening and Senescence	2(1+1)
222	PHT	21HO3207	Novel Processing Technologies for Horticultural Produce	3(2+1)
223	PHT	21HO3208	Advances in Laboratory Techniques in Post-Harvest Technology	3(1+2)
224	PHT	21HO3209	Advances in Packaging Technology of Horticultural Produce	2(1+1)
225	PHT	21HO3210	Storage Techniques and Supply/Cold Chain Management of Horticultural Produce	3(2+1)
226	PHT	21HO3211	Doctoral Seminar I	1(1+0)
227	PHT	21HO3212	Doctoral Seminar II	1(1+0)
228	PHT	21HO3213	Doctoral Research	75(0+75)
229	BTH	21AG3214	Plant Biochemistry	3(2+1)
230	BTH	21AG3215	Principles of Plant Physiology	3(2+1)
231	SAC	21AG3216	Soil Fertility and Fertilizer Use	3(2+1)
232	AEC	21AG3217	Experimental Designs	3(2+1)
233	AGR	21AG3218	Remote Sensing and GIS Techniques for Soil, Water and Crop Studies	3(2+1)
234	AEC	21AG3219	Data Analysis using Statistical Packages	3(2+1)
235	Common Course	21AG3222	Library and Information Services	1(0+1)
236	Common Course	21AG3223	Technical writing and Communications Skills	1(0+1)
237	Common Course	21AG3224	Intellectual Property and its management in Agriculture	1(1+0)
238	Common Course	21AG3225	Basic concepts in Laboratory Techniques	1(0+1)
239	Common Course	21AG3226	Agricultural Research, Research Ethics and Rural Development Programs	1(1+0)
240	BTH	21AG3227#	Introduction to Bioinformatics	3(2+1)
241	BTH	21AG3228#	Physiological and Molecular Responses of Plants to Abiotic Stresses	3(2+1)
242	PAT	21AG3232#	Current topics in Nematode Disease Development and Host Resistance	3(2+1)
243	AEC	21AG3233#	Advanced Design of Experiments	2(2+0)
244	AEC	21AG3235#	Mathematical Modeling in Agricultural Sciences	2(1+1)
245	AGR	21AG3236#	Weather Forecasting Methods and Yield Prediction	3(2+1)

*Non gradial course (NC) #Supporting courses for Ph.D.

21AG1001 FUNDAMENTALS OF AGRONOMY

Credits: 3:0:1 (3+1)

Course Objectives:

To impart knowledge on

1. Cultivation of crops, growing seasons, and crop classification
2. Planting, growth and development, crop nutrition, fertilizer recommendation and weed management
3. Crop rotation, distribution and adaptation, crop management, harvesting and threshing of crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand basics of crop characteristics and its classification
2. Outline the basics of crop characteristics and its classifications
3. Identify crops, seeds, fertilizers, pesticides, farm /tillage implements
4. Acquire scientific knowledge on weeds, its impacts on crop growth and integrated weed management
5. Apply fundamentals of growth concepts, factors influencing and its relationship to nutrients applied
6. Describe crop rotation, its principles and apply knowledge of crop management techniques in crop production

Theory

Agronomy and its scope, seeds and sowing, tillage and tilling, crop density and geometry, crop and its classifications, Crop nutrition, manures and fertilizers, nutrient use efficiency, Weeds- importance, classification, crop weed competition, concepts of weed management, principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, study of agro-climatic zones of India, Identification of weeds in crops, Methods of herbicide and fertilizer application, Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements- reversible plough, one way plough, harrow, leveler, seed drill.

References

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4. De, G.C.1989. Fundamentals of Agronomy. Oxford & IBH Publishing Co., New Delhi.
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6. Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th ed.). Pearson Education, Delhi.
7. Rao, V.S. 2000. Principles of Weed science. Oxford & IBH Publishing Co. New Delhi.
8. Sankaran, S. and Subbiah Mudaliar, V.T. 1991.Principles of Agronomy. Bangalore, Printing & Publishing Co., Bangalore

21AG1002 AGRICULTURAL HERITAGE

Credits: 1:0:0 (1+0)

Course Objectives:

To impart knowledge on

1. Importance and origin of agriculture, agricultural systems and resources in India
2. Agricultural development and Green revolution in India
3. Agricultural education, Farm mechanization and Women empowerment in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand agricultural heritage of India, agricultural resources and development of Indian agriculture from ancient to modern era
2. Compare indigenous traditional knowledge in agriculture and crop voyage in India and the world
3. Describe gender perspective, tasks of farm women, women empowerment and self-help groups
4. Apply Indigenous Traditional Knowledge (ITK) in modern agricultural practices
5. Visualize transition of agriculture from past to present
6. Acquire knowledge on gender issues in agriculture for women empowerment and implement women-friendly agricultural technologies

Theory

Agriculture scope; Importance of agriculture and agricultural resources available in India; Origin of agriculture-branches of agriculture- agricultural systems in the world-Crop significance and classifications; Green revolution and its impact- National agriculture setup in India; ICAR and SAUs- Current scenario of Indian agriculture; Indian agricultural concerns and future prospects-CGAIR and international institutions. Introduction of Indian agricultural heritage; Ancient agricultural practices, Relevance of heritage to present day agriculture; Past and present status of agriculture and farmers in society; Journey of Indian agriculture and its development from past to modern era; Natural calamities and famines- Plant production and protection through indigenous traditional

knowledge; Crop voyage in India and world; Introduction to gender perspectives in agriculture- gender concepts- multiples roles of women- Women in agriculture- multifaceted roles and tasks of farm women- gender, poverty and livelihoods. Gender equity and strategies for rural women's empowerment- self- help groups. Farm mechanization and women- Occupational health hazards- Women friendly agricultural technology- Ergonomical approaches- Technological options

References

1. Randhawa, M.S. 1980-1986. A History of Agriculture in India Vol. I to IV Indian Council of Agricultural Research, New Delhi.
2. Ahmed, S. 2004. Gender Issues in Agricultural and Rural Livelihoods-Vol. I M.S. Swaminathan Research Foundation, Chennai and Kerala Agricultural University, Thrissur.
3. Commonwealth Secretariat.1996. Women and Natural Resource Management: A Manual for the Asian Region. Gender and Youth Affairs Division, London.
4. Noor Mohammed.1992. Origin, diffusion and development of agriculture. In: Noor Mohammed (ed.), New Dimensions in Agricultural Geography: Vol.1.Historical Dimensions of agriculture. Concept publishing Co., New Delhi. Pp 29-75.
5. Handbook of agriculture, 2012, ICAR, New Delhi
6. Adhikary, M.M. 2019. Textbook of Agricultural Heritage. IPB publishers, New Delhi.
7. Kumari, D. and M. Veeral. 2012. A text book on agricultural heritage of India. Agrotech publishers, New Delhi, India.

21AG1003 INTRODUCTION TO FORESTRY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The importance of forest and agroforestry systems in sustaining the land productivity
2. Crop tree interactions in different types of agroforestry systems
3. Productive and protective functions of agroforestry

Course Outcomes:

On completion of this course, students will be able to

1. Understand the forest eco system and forest regeneration.
2. Remember the concepts of agroforestry practiced in various agro ecosystems
3. Apply the knowledge for developing agro forestry, wind breaks, shelter belts, silviculture and social forestry
4. Recall the multipurpose trees in agroforestry systems
5. Analyze the impact of nitrogen fixation, carbon sequestration and develop strategies for climate mitigation
6. Explain the beneficial effects of agro forestry in relation to nitrogen fixation, soil conservation, litter dynamics and nutrient cycles

Theory

Introduction – definitions of basic terms related to forestry, importance and objectives of silviculture, types of forests-salient features of Indian Forest Policies. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; artificial regeneration: objectives, choice between natural and artificial regeneration, essential preliminary considerations, tree stand management. Agroforestry: Definition and concepts, agroforestry systems and practices, different agroforestry systems prevalent in the country and Tamil Nadu, shifting cultivation, taungya, alley cropping, windbreaks and shelter belts, plantation crop combinations, home gardens. Multipurpose trees in agroforestry, characteristics, under storey components and diversification potentials, component interactions: above ground and belowground interactions. Productive and protective functions, nitrogen fixation, soil conservation, litter dynamics and nutrient cycling. Carbon sequestration and climate change mitigation, social forestry, concept and importance, practices in different agro ecosystems

Practical

Identification of tree-species. Diameter measurements using calipers and tape. Height measurement of standing trees by shadow method, single pole method and hypsometer. Nursery lay out, seed sowing, vegetative propagation techniques. Different agroforestry systems like Agrisilvicultural systems, Silvopastoral systems, Agrosilvopastoral systems and their interactions

References

1. Puri, S and Panwar, P. (ed.). 2007. Agroforestry Systems and Practices. New India Publishing Agency, New Delhi.
2. Gupta, R.K. 1993. Multipurpose Trees for Agroforestry and Wasteland Utilization. Oxford and IBH.

21AG1051 FUNDAMENTALS OF AGRICULTURAL ECONOMICS

Credits: 2:0:0 (2+0)

Course objectives:

To impart knowledge on

1. Principles of economics and to get an idea of macro and micro economics
2. Basic theories of economics, concepts of agricultural economics and its relation with other subjects
3. Different credit and tax systems in agriculture.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the principal and theories and its role in planning for economic development of the country
2. Remember consumer behaviour - utility maximization problem and demand theory.
3. Gain knowledge on fundamental concepts about theory of production and cost: price and output determination across market structures.
4. Evaluate different agricultural finance systems and their role as credit agencies
5. Gain knowledge on different taxes applicable to agriculture.
6. Analyse theory of general equilibrium and welfare economics.

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macro-economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. *Demand*: meaning, law of demand, schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi- marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. *Laws of returns*: Law of variable proportions and law of returns to scale. *Cost*: concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, schedule, supply curve, determinants of supply, elasticity of supply. Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break-even points. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. *National income*: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programs on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy. Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure. *Tax*: meaning, direct and indirect taxes, agricultural taxation, GST. *Economic systems*: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

References

1. Ahuja.H.L. 2016. Macro Economics Theory and Policy. 20th ed, S. Chand and Company Limited, New Delhi.
2. Dewett, K.K and Navalur, M.H. 2013. Modern Economic Theory. S. Chand & Sons, New Delhi.
3. Dewett, K.K. and Verma. 2004. Elementary Economic Theory. S.Chand, New Delhi
4. Jhingam, M.L.2001. Micro Economic Theory. Konark publishers, NewDelhi
5. Reddy S, Raghuram.P Neelakanta Sastry, T.V Bhavani Devi, I. 2009. Agricultural Economics. 2Ed Published by Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

21AG1101 COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Structural and functional grammar.
2. Writing and oral presentation skills
3. Group presentations and group discussions

Course Outcomes:

On completion of this course, students will be able to

1. Apply indexing, footnote and bibliographic procedures
2. Understand the comprehension of articles.
3. Summarize and abstract.
4. Participate and organize group discussions and seminars
5. Develop listening, writing and oral presentation skills
6. Maintain field diary and lab record

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, foot note and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations.

References

1. Balasubramanian T. 1989. A Textbook of Phonetics for Indian Students. Orient Longman, New Delhi.
2. Balasubramanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
3. Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
4. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
5. Krishnaswamy, N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
6. Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
7. Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.

21AG1151 FUNDAMENTALS OF ENTOMOLOGY

Credits: 3:0:1 (3+1)

Course objectives:

To impart knowledge on

1. Insect morphology, anatomy and physiology
2. Insect systematics
3. Insect ecology, classification of pesticides and concept of different pest management techniques

Course outcomes:

On completion of this course, students will be able to

1. Understand insect external body parts and their modifications
2. Remember insect orders and families of agriculturally important pests
3. Acquire knowledge on structure of various organ systems and their functions
4. Analyze the factors influencing pest occurrence
5. Explain the basis of insect ecology
6. Recommend integrated pest management strategies

Theory

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouthparts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor. Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance. Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control importance, hazards and limitations. Recent methods of pest control, repellents, anti-feedants, hormones, attractants, and gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes. Systematics: Taxonomy and its importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-

species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

References

1. Gullan, P. J. and Cranston, P. S. 2014. The insects: an outline of entomology. (8th Ed.) Wiley Blackwell
2. Metcalf, C. L. and Flint, W. P. 1973. Destructive and Useful Insects. Tata Mc Graw Hill Publishing Co. New Delhi.
3. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. 1979. General and Applied Entomology. Tata Mc Graw Hill Publishing Co. New Delhi.
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5. Pant, N. C. and Ghai, S. 1973. Insects Physiology and Anatomy. I CAR. New Delhi, 332 p. 6.
6. Richards, O. W. and Davies, R. G. 1977. Imms General Textbook of Entomology. Vol. II Chapman and Hall, London.
7. Snodgrass, R. E. 1935. Principles of Insect Morphology. Tata Mc Graw Hill Publishing Co. New Delhi.

21AG1201 FUNDAMENTALS OF GENETICS

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Fundamentals of Mendelian inheritance and gene interactions
2. Concept of linkage and its determination, chromosomal aberrations and ways to induce it.
3. Cytoplasmic inheritance and its applications, genetic makeup of cell and the process and regulation of gene synthesis

Course Outcomes:

On completion of this course, students will be able to

1. Solve problems on Mendelian genetics
2. Construct gene map using linkage
3. Identify the type of aberrations and its usage in agriculture
4. Understand inducing mutation by artificial methods
5. Explain the central dogma of life
6. Adopt the knowledge of cytoplasmic inheritance in plant breeding

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome: chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere: special types of chromosomes. Chromosomal theory of inheritance - cell cycle and cell division- mitosis and meiosis. Probability and Chi-square. Dominance relationships, epistatic interactions with example. Multiple alleles; pleiotropism and pseudoalleles. Sex determination and sex linkage: sex limited and sex influenced traits, Blood group genetics, linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications, Use of haploids, dihaploids and doubled haploids in genetics. Mutation; classification, methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation. Qualitative and Quantitative traits: Polygenes and continuous variations, multiple factor

hypothesis, cytoplasmic inheritance. Genetic disorders; nature, structure and replication of genetic material. Protein synthesis: transcription and translational mechanism of genetic material, Gene concept: gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope. Study of cell structure. Mitosis and Meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross. Practice on mitotic and meiotic cell division. Experiments on probability and Chi-square test. Determination of linkage and crossover analysis (through two-point test cross and three-point test cross data). Study on sex linked inheritance in *Drosophila*. Study of models on DNA and RNA structures.

References

1. Gardner, J., M. J. Simmons and D.P. Snustad, 2009. Principles of Genetics (8th Ed.). Wiley India Pvt. Ltd., New Delhi.
2. Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
3. Singh, B.D. 2000. Fundamentals of Genetics (6th Ed.). Kalyani Publishers, Ludhiana
4. Singh, P. 1995. Elements of Genetics. Kalyani Publishers, Ludhiana.
5. <http://www.agrimoon.com/agriculture-icar-ecourse-pdf-book/> TNAU (ICAR)

21AG1301 FUNDAMENTALS OF SOIL SCIENCE

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Soil forming process and physical properties of soil
2. Soil chemical properties and reactions
3. Impact of soil pollution and remediation measures

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genesis, pedological and edaphological concepts of soil
2. Remember different systems of soil classification
3. Explain and evaluate the physical properties of soil
4. Explain and estimate the physio- chemical properties of soil
5. Describe the biological properties of soil and its influence
6. Analyze the soil pollutant factors and recommend suitable remedial measures for soil improvement

Theory

Soil as a natural body: pedological and edaphological concepts of soil. Soil genesis: soil forming rocks and minerals, weathering, processes and factors of soil formation, soil Profile and components of soil. Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity. Elementary knowledge of soil taxonomy classification and soils of India, soil water retention, movement and availability. Soil air: composition, gaseous exchange, influence on plant growth. Soil temperature: source, amount and flow of heat in soil, effect on plant growth, soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability. Soil colloids: inorganic and organic, silicate clays, constitution and properties, sources of charges, ion exchange, cation exchange capacity, base saturation. Soil organic matter: composition, properties and its influence on soil properties, humic substances - nature and properties. Soil organisms: macro and microorganisms, their beneficial and harmful effects. Soil pollution - point and non-point sources behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Study of soil profile in field. Identification of glassware and laboratory rules. Preparation of standard solution and standardization (concept of normality, molarity, molality, ppm) Study of soil sampling tools, collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil. Determination of soil colour. Determination of soil heat. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Estimation of organic matter content of soil.

References

1. Black, C.A. 1982. Methods of Soil Analysis, Part I ASA, Madison, USA.
2. Brady, N.C. 2016. Nature and Properties of Soils. 15th Edn., Macmillan Publishing Co. Inc., New York.
3. Das, D.K. 2015. Introductory Soil Science. 4th Edn., Kalyani Publishers, New Delhi.
4. Indian Society of soil science. 2012. Fundamentals of Soil Science (2nd Edn.). IARI, New Delhi
5. Biswas, T.D. and S.K. Mukherjee, 2016. Text Book of Soil Science. (2nd Edn). Tata McGraw Hill Publishing Co., New Delhi.

6. <https://agrimoon.com/introduction-to-soil-science-icar-ecourse-pdf-book/>
7. <https://www.pdfdrive.com/principles-and-practice-of-soil-science-the-soil-as-a-natural-resource/>

21AG1302 INTRODUCTORY AGRO-METEOROLOGY & CLIMATE CHANGE

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Agricultural meteorology and its role in crop production
2. Atmospheric weather variables, climatic factors and their measurements
3. Climate change and its effect on crop production

Course Outcomes:

On completion of this course, students will be able to

1. Understand the significance of agricultural metrology, climate and weather
2. Discuss the various atmospheric weather variables and its significance in crop production
3. Understand crop weather relationships for efficient crop production
4. Acquire knowledge on weather forecasting techniques and effect of climate change on crop production
5. Describe artificial rainmaking, precipitation, monsoons and its importance in Indian Agriculture
6. Discuss global warming, and its effect on regional and national agriculture

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze. Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature. Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon mechanism and importance in Indian agriculture, Weather hazards: drought, floods, frost, tropical cyclones and extreme weather conditions such as heat wave and cold wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock production. Weather forecasting types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

References

1. Prasada Rao, G.S.L.H.V. 2005. Agricultural Meteorology. Second Edition. Kerala Agricultural University, Thrissur
2. Mavi, H.S. 1986. Introduction of Agrometeorolgy. Oxford & IBH Publishing Co. New Delhi
3. Varshneya, M.C. and B.Balakrishna Pillai. 2003. Textbook of Agricultural Meteorology. ICAR, New Delhi

21AG1303 AGRICULTURAL MICROBIOLOGY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of microorganisms in agriculture and understanding of soil microbiology
2. Classification of microorganisms, functions and its role in soil fertility
3. Scope of microbes in human welfare, production of silage, biofertilizers, biopesticides, biofuels, and biodegradation of agricultural wastes

Course Outcomes:

On completion of this course, students will be able to

1. Comprehend the importance and role of microbes in agricultural production
2. Understand principles of microscopy, sterilization techniques and nutrient media preparation
3. Enumerate microbial load in soil and perform isolation, culturing and purification of microbes
4. Explain the role of microbes in enhancing soil fertility
5. Employ genetic transformation methods using microbes in crop improvement
6. Explore and develop biofertilizers, biopesticides and biofuels

Theory

Introduction. Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro- waste.

Practical

Introduction to microbiology laboratory and its equipment; Microscope- parts, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and their preparations. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes. Methods of isolation and purification of microbial cultures. Isolation of *Rhizobium* from legume root nodule. Isolation of *Azotobacter* from soil. Isolation of *Azospirillum* from roots. Isolation of BGA. Staining and microscopic examination of microbes.

References

1. Alexander, M. 1985. Introduction to Soil Microbiology. John Wiley & Sons, New York.
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 1993. Microbiology. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Stanier, R.Y., Ingraham, Wheelis, M.G. and Paintor, P.R. 1986. The Microbiology World. Prentice Hall, New Jersey.
4. Subba Rao, N.S. 1999. Biofertilizers in Agricultural and Agroforestry. Oxford & IBH New Delhi
5. <http://www.agrimoon.com/agriculture-icar-ecourse-pdf-book/> TNAU (ICAR)

21AG1351 FUNDAMENTALS OF PLANT PATHOLOGY

Credits: 3:0:1 (3+1)

Course Objectives:

To impart knowledge on

1. Plant diseases and plant pathogens
2. Classification and life cycle of plant pathogens
3. Basics of plant disease management

Course Outcomes:

On completion of this course, students will be able to

1. Remember the factors responsible for disease development
2. Understand the importance of different plant pathogens with their characteristics and classification
3. Recall the reproduction, survival and transmission of plant pathogens
4. Outline the mode of dispersal, role of enzymes and toxins in disease development
5. Analyze defense mechanism in plants and the epidemiological factors
6. Apply knowledge on plant disease management

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes/ factors affecting disease development: disease triangle, tetrahedron, and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes. Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes. Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction. Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites. Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (*Heterodera*, *Meloidogyne*, *Anguina*, *Radopholus* etc.) Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants. Epidemiology: Factors affecting disease development. Principles and

methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

References

1. Agrios, G. N. 2005. Plant Pathology. 5th Ed. Elsevier Academic Press.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 2014. Introductory Mycology. 4th Ed .Wiley India Pvt td.
3. Jayaraman, J. and Verma, J. P. 2002.Fundamentals of Plant Bacteriology (Reprint, 2015). Kalyani publishers, New Delhi
4. Ravichandra, N.G. 2013. Fundamentals of Plant Pathology. PHI Learning Pvt Ltd.639p.
5. Walkey, D. G. 1991. Applied Plant Virology (2nd Ed.). Springer.
6. Webster, J. and R.W.S. Weber. 2007. Introduction to Fungi. 3rd Ed.. Cambridge University press.
7. Thorne, G. 1971. Principles of Nematology, McGraw Hill Book Co., New York, London

21AG1451 INTRODUCTORY SOIL AND WATER CONSERVATION ENGINEERING

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Concept of soil and water conservation
2. Various causes for soil erosion
3. Soil and water conservation measures

Course Outcomes:

On completion of this course, students will be able to

1. Understand basic concepts of soil and water conservation
2. Explain the gully erosion control measures
3. Measure the soil loss using different techniques
4. Explain the water harvesting techniques
5. Understand the mechanics of wind erosion
6. Explain the different control measures of wind erosion

Theory

Introduction to soil and water conservation causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal soil loss equation. Soil loss measurement techniques.Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed waterways and their design. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

1. Calculation of erosion index. Estimation of soil loss
2. Measurement of soil loss
3. Preparation of contour maps
4. Design of grassed waterways
5. Design of contour bunds
6. Design of graded bunds
7. Design of bench terracing system
8. Problem on wind erosion

Text Books

1. Mahnot, S. C. 2014. Soil and water conservation and watershed management. International Books and Periodicals Supply Service, NewDelhi.
2. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
3. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of soil and water conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., NewDelhi.
4. Michael, A. M. and T. P. Ojha. 2003. Principles of Agricultural Engineering. VolumeII. 4th Edition,

Jain Brothers, New Delhi.

References

1. Murthy, V. V. N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
2. Frevert, R. K., G. O. Schwab, T. W. Edminster and K. K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

21AG1501 FUNDAMENTALS OF PLANT BIOCHEMISTRY AND BIOTECHNOLOGY

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Importance of biomolecules their structure, classification and function
2. Synthesis and storage of metabolic energy
3. Role of biochemistry in medicine, agriculture and pharmaceutical industries

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of biomolecules in medicine, agriculture, pharmaceuticals and ethics
2. Remember the structure and classification of biomolecules
3. Recall the role of biomolecules in photosynthesis, protein synthesis and DNA synthesis
4. Remember the developments in biochemistry
5. Explain the overall aspects of integration of metabolic processes
6. Apply the knowledge on structure of carbohydrates, proteins, vitamins, nucleic acids and lipids in drug discovery

Theory

Importance of biochemistry. Properties of water, pH and buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides: reducing and oxidizing properties of monosaccharides. Mutarotation: structure of disaccharides and polysaccharides. Lipid: importance and classification; structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: importance of proteins and classification; structures, titration and zwitterions nature of amino acids; structural organization of proteins. Enzymes: general properties; classification; Mechanism of action; Michaelis and Menten and Line Weaver Burk equation and plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; structure of Nucleotides, A, B and Z DNA; RNA: types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, glyoxylate cycle, Electron transport chain. Metabolism of lipids: beta-oxidation, biosynthesis of fatty acids. Concepts and applications of plant biotechnology: scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications. Micro-propagation methods: organogenesis and embryogenesis, synthetic seeds and their significance, Embryo rescue and its significance. Somatic hybridization and cybrids: somaclonal variation and its use in crop improvement, cryo-preservation. Introduction to recombinant DNA methods: physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods. Transgenic and its importance in crop improvement; PCR techniques and its applications; RFLP, RAPD, SSR; Marker Assisted Breeding in crop improvement; Biotechnology regulations.

Practical

Preparation of solution, pH and buffers, qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ monosaccharides. Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants. Micro-propagation, hardening and acclimatization. Demonstration on isolation of DNA. Demonstration of gel electrophoresis techniques and DNA finger printing.

References

1. Jain, L. 2001. Fundamentals of Biochemistry, 5th Edition, S. Chand & company, New Delhi.
2. Lehninger, A.L., D.L Nelson and M.M. Cox. 2017. Principles of Biochemistry. W.H Freeman and Company (MacMillan Publishers), USA
3. Thayumanavan, B, S. Krishnaveni and K. Parvathi. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications, New Delhi.
4. Verma, S.K. 2000. A Text Book of Plant Physiology and Biochemistry, S. Chand & company, New Delhi.
5. Brown T A. 2002. Genomes 2. 2nd ed. New York: Wiley-Liss.

6. Prave P, Faust U & Sittig W. 1987. Fundamentals of Biotechnology. VCH Verlagsgesellschaft.
7. Chawla, H.S. 2012. Introduction to plant biotechnology. IBH publishing Co.
8. Singh, B. D. 2013. Molecular biology, genetic engineering and applications of biotechnology. Kalyani Publishers

21AG1503 FUNDAMENTALS OF CROP PHYSIOLOGY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Concept of water relations in plants
2. Physiological processes of plant and its effects on plant growth
3. Role of plant growth regulator and its application in crop growth

Course Outcomes:

On completion of this course, students will be able to

1. Understand the physiology of plant tissues and cells
2. Remember water movement in plant systems like diffusion and osmosis
3. Apply the concept of water relations, mineral uptake in the field of agriculture
4. Summarize the various physiological processes
5. Measure and analyze the physiological parameters of crops
6. Practice the use of growth regulators correctly to solve physiological problems

Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; Photosynthesis: Light and Dark reactions, C₃, C₄ and CAM plants; Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism: Fatty acid synthesis and Breakdown; Plant growth regulators: Physiological roles and agricultural uses, Physiological aspects of growth and development of major crops: Growth analysis, Role of Physiological growth parameters in crop productivity.

Practical

Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, Separation of photosynthetic pigments through paper chromatography, Rate of transpiration, photosynthesis, respiration, tissue test for mineral nutrients, estimation of relative water content, Measurement of photosynthetic CO₂ assimilation by Infra Red Gas Analyzer (IRGA).

References

1. Jain, J.K. 2007. Fundamentals of plant physiology, S.Chand & Company Ltd., New Delhi.
2. Pandey, S. N. and B. K. Sinha, 2006. Plant Physiology. Vikas Publishing House Private Limited, New Delhi.
3. Ray Noggle, G. and Fritz, G. J., 1991. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Taiz, L. and Zeiger, E., 2006. Plant Physiology. Publishers: Sinauer Associates, Inc., Massachusetts, USA.

21AG2004 CROP PRODUCTION TECHNOLOGY - I (KHARIF CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Fundamental understanding of *kharif* season
2. Economic importance of *kharif* crops
3. Cultural practices of *kharif* crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the crop production technology for *kharif* crops
2. Gain knowledge on geographical distribution of *kharif* crops
3. Recall the morphological features and crop production requirements for *kharif* season crops
4. Remember soil and climatic requirements of different *kharif* crop varieties
5. Acquire the knowledge on crop management practices for *kharif* season
6. Apply the acquired knowledge to guide the farmers for cultivating *kharif* crops

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses- pigeon

pea, mung bean and urd bean; oilseeds- groundnut, and soybean; fibre crops- cotton & jute; forage crops-sorghum, cowpea, cluster bean and napier grass.

Practical

Rice nursery preparation, transplanting of rice, sowing of soybean, pigeonpea and mungbean. maize, groundnut and cotton, effect of seed size on germination and seedling vigour of kharif season crops, effect of sowing depth on germination of kharif crops, identification of weeds in kharif season crops, top dressing and foliar feeding of nutrients. Study of yield contributing characters and yield calculation of kharif season crops. Study of crop varieties and important agronomic experiments at experimental farm. Study of forage experiments, morphological description of kharif season crops, visit to research centres of related crops.

References

1. Prasad, R. (ed.). 2001. *Field Crop Production*. ICAR, New Delhi
2. Pal, M., Deka, J. and Rai, R.K. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill Pub., New Delhi
3. Singh, C., Singh, P., and Singh, R. 2003. *Modern Techniques of Raising Field Crops* (2nd ed.). Oxford & IBH, New Delhi.
4. Crop Production Guide Agriculture. 2020. Directorate of Agriculture & Tamil Nadu Agricultural University.
5. Reddy, S.R. 2015. *Agronomy of field crops*. Kalyani Publishers, New Delhi.
6. Mukund Joshi. 2018. *Text book of field crops*. PHI learning pvt. Ltd. New Delhi

21AG2005 CROP PRODUCTION TECHNOLOGY-II (RABI CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Economic importance of *Rabi* crops
2. Management for *Rabi* crop production
3. Cultural practices of *Rabi* crops

Course Outcomes:

On completion of this course, students will be able to

1. Know Economic importance of *Rabi* crops
2. Understand agro-ecological requirements for *Rabi* crop production.
3. Apply cultural practices of Wheat and Barley.
4. Apply cultural practices of oilseeds and pulses
5. Apply cultural practices of sugarcane and medicinal crops
6. Understand innovations and research advancements in *Rabi*

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals –wheat and barley, pulses-chickpea, lentil, peas, oilseeds- rapeseed, mustard and sunflower; sugar crops-sugarcane; medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops-berseem, lucerne and oat.

Practical

Sowing methods of wheat and sugarcane, identification of weeds in *rabi* season crops, study of morphological characteristics of *rabi* crops, study of yield contributing characters of *rabi* season crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of *rabi* crops at experimental farms. Study of *rabiforage* experiments, oil extraction of medicinal crops, visit to research stations of related crops.

References

1. Prasad, R. (ed.). 2001. *Field Crop Production*. ICAR, New Delhi
2. Pal, M., Deka, J. and Rai, R.K. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill Pub., New Delhi
3. Singh, C., Singh, P., and Singh, R. 2003. *Modern Techniques of Raising Field Crops* (2nd ed.). Oxford & IBH, New Delhi.
4. Crop Production Guide Agriculture. 2020. Directorate of Agriculture & Tamil Nadu Agricultural University.
5. Reddy, S.R. 2015. *Agronomy of field crops*. Kalyani Publishers, New Delhi.
6. Mukund Joshi. 2018. *Text book of field crops*. PHI learning pvt. Ltd. New Delhi.

21AG2006 FARMING SYSTEMS & SUSTAINABLE AGRICULTURE

Credits 1:0:0 (1+0)

Course Objectives:

To impart knowledge on

1. Sustainable agriculture
2. Scope and efficiency maximization through integrated farming systems
3. Different farming systems and its interaction in farm productivity

Course Outcomes:

On completion of this course, students will be able to

1. Understand sustainability of Agriculture and its importance.
2. Differentiate the types of farming and cropping systems.
3. Relate sustainable agriculture and conventional agriculture
4. Analyze indicators of sustainability, adaptation, mitigation and conservation.
5. Apply site-specific integrated farming systems for sustainability.
6. Use farm resources efficiently.

Theory

Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

References

1. Palaniappan S. and Sivaraman, 1996, Cropping systems in the tropics principles and management, New Age International Pvt. Ltd., New Delhi
2. Jayanthi C., Devasenapathy and C. Vennila, 2007, Farming System Principles and Practices, Satish Serial Publishing House, New Delhi
3. S. C. Panda, 2003, Cropping and Farming Systems, Agrobios Publishers, Jodhpur.
4. Reddy, S.R. 2018. Farming System and Sustainable Agriculture. Kalyani Publishers, New Delhi.
5. Walia, S.S. and U.S. Walia. 2020. Farming System and Sustainable Agriculture. Scientific publishers, Jodhpur, Rajasthan.
6. Nanwal, R.K. 2020. Farming System and Sustainable Agriculture. New India Publishing Agency, New Delhi.

21AG2007 PRACTICAL CROP PRODUCTION-I (KHARIF CROPS)

Credits 0:0:2 (0+2)

Course Objectives:

To impart knowledge on

1. Practical cultivation practices of *kharif* crops
2. The phenological phases and its significance of each phase in crop production
3. Calculation and estimation of yield and other parameters influencing crop yield

Course Outcomes:

On completion of this course, students will be able to

1. Demonstrate practical cultivation of *kharif* crops
2. Identify problems in *kharif* cultivation and to offer solutions
3. Suggest marketing channels for products of cultivation
4. Operate modern farm equipment
5. Optimize resource utilization and recommend package of practices for *Kharif* crops
6. Construct a balance sheet showing cost of cultivation and net income generated

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies.

Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students. Important kharif crops like rice and maize will be raised.

Reference

1. Rajendra Prasad. 2006. Text book of field crops, ICAR, New Delhi
2. Mukund Joshi. 2015. Text book of field crops, PHI Learning Private Ltd., New Delhi
3. Chidda Singh. 1997. Modern techniques of raising field crops, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi
4. Crop Production Guide Agriculture. 2020. Directorate of Agriculture & Tamil Nadu Agricultural University

21AG2008 GEOINFORMATICS AND NANO TECHNOLOGY AND PRECISION FARMING

Credit 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of GIS, GPS and drones in agriculture
2. Sensors and its application in agriculture
3. Crop simulation models and their role in precision farming

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concept of precision farming
2. Relate the use of GIS and GPS systems in drip installation and fertigation techniques
3. Demonstrate use of Unmanned Aerial Vehicle (UMAV) to gather information
4. Develop precision farming technology for important crops.
5. Analyze applications of sensors in agriculture
6. Apply Crop Simulation models and Site-Specific Management using GIO referencing

Theory

Precision farming - Introduction - concept and importance. Tools - role of GIS and GPS – Un Manned Aerial Vehicle (UMAV) - Mobile mapping system and its application in precision farming; Design layout and installation of drip and fertigation; Site specific management (SSM) - geo-referencing and photometric correction; Sensors - information gathering and application; Crop simulation models - role in precision farming. Precision farming technology- crops -cotton - banana and tomato.

Practical

Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques: crop simulation models; Design - layout and installation of drip and fertigation techniques

References

1. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
2. Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.
3. Ancha Srinivasan. 2006. Handbook of precision agriculture principles and applications. The Haworth press. Binghamton. Inc., New York.
4. Zhang Q, 2015. Precision Agriculture Technology for Crop Farming, Taylor & Francis.
5. Rattan Lal and B.A..Stewart. 2015. Soil specific farming-Precision Agriculture. CRC Press, American Publishing group.
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7. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
8. Adams, C.R. K.M. Band ford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Daryaganj, New Delhi.
9. Lyn. Malone, Anita M. Palmer, Christine L. Vloghat, and J. Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
10. David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA

21AG2009 RAINFED AGRICULTURE & WATERSHED MANAGEMENT

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Systems of rainfed agriculture, land suitability, and farming practices in rainfed regions

2. Adaptation and mitigation strategies, crop planning and crop management techniques
3. The concepts, principles and components of water conservation and management

Course Outcomes:**On completion of this course, students will be able to**

1. Understand sustainable agriculture practices under rainfed conditions
2. Remember soil and climatic conditions of rainfed areas
3. Explain the various crop management techniques and the adaptation strategies for dry land agriculture
4. Formulate contingent water planning for aberrant weather conditions
5. Apply knowledge of different water conservation methods and effective water utilization through use of watershed management
6. Simulate artificial hydrologic watersheds and manage the watersheds effectively

Theory

Rainfed agriculture: Introduction, types, History of rainfed agriculture and watershed in India; Problems and prospects of rainfed agriculture in India ; Soil and climatic conditions prevalent in rainfed areas; Soil and water conservation techniques, Drought: types, effect of water deficit on physio-morphological characteristics of the plants, Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices, Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought period in the country, effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress. Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

References

1. Dhruva Narayana, 1993, Soil and Water Conservation Research in India, ICAR, New Delhi
2. Handbook of Agriculture, ICAR, New Delhi
3. Suresh, 2016, Soil and Water Conservation Engineering, New Delhi
4. Rayees Ahmed, 2017, Rainfed Agriculture and Watershed Management, Kushal Publications
5. Nanwal, R.K. 2019. Rainfed agriculture and watershed management. New India Publishing Agency, New Delhi.
6. Pawar. P.B., Jagtap, T.N. and U.V. Mahadkar. 2018. A textbook on rainfed agriculture and watershed management. Sri Rajlaxmi prakasan, Aurangabad.
7. Suhas P. Wani, Johan Rockstrom and Kanwar Lal. 2012. Integrated Watershed Management in Rainfed Agriculture. CRC press.

21AG2010 PRACTICAL CROP PRODUCTION-II (RABI CROPS)

Credits 0:0:2 (0+2)

Course Objectives:**To impart knowledge on**

1. Practical training on cultivation practices of *rabi* crops
2. Phenological phases and significance of each phase in crop production
3. Estimating yield and other parameters influencing crop yield

Course Outcomes:**On completion of this course, students will be able to**

1. Understand cultivation practices of *rabi* crops
2. Identify problems related to *rabi* crop production and offer solutions
3. Suggest marketing channels for products of cultivation
4. Operate modern farm equipment
5. Optimize resource utilization and recommend package of practices for *rabi* crops
6. Construct a balance sheet with inputs of cultivation costs and net income generated

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests, diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production,

mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students. Important Rabi crops like sunflower will be raised.

References

1. Rajendra Prasad, 2006, Text book of field crops, ICAR, New Delhi
2. Mukund Joshi, 2015, Text book of field crops, PHI Learning Private Ltd., New Delhi
3. ChiddaSingh, 1997, Modern techniques of raising field crops, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi
4. Crop Production Guide Agriculture. 2020. Directorate of Agriculture & Tamil Nadu Agricultural University

21AG2011 PRINCIPLES OF ORGANIC FARMING

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Historical, physio-chemical, biological and ecological basis of organic farming including various crop and soil management practices
2. Agronomic practices and farming techniques of different crops and cropping systems under organic farming
3. The concepts related to legislation, inspection, certification, and marketing of organic produces

Course Outcomes:

On completion of this course, students will be able to

1. Remember the concepts of organic farming
2. Understand the crop management practices and technologies of various crops
3. Recall the different cropping systems of Tamil Nadu
4. Compare the organic crop production with inorganic crop production
5. Apply the knowledge of standards, certification process
6. Analyze different marketing strategies of organic farm products

Theory

Organic farming, principles and its scope in India; Initiatives taken by Government (central/ state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

Practical

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management; Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling.

References

1. Handbook of Agriculture, ICAR, New Delhi
2. Masanobu Fukuoka. 2017. One straw revolution – An introduction to natural farming. NYRB Classics Korn
3. S.P.Palaniappan and K. Annadurai. 2010. Organic farming theory and practices, Scientific Publishers
4. S.R. Reddy, 2017, Principles of Organic Farming, Kalyani Publishers
5. Mamta and Bansal. 2017. Basics of organic farming. CBS Publication, New Delhi.

21AG2052 AGRICULTURAL FINANCE AND COOPERATION

Credits: 2:0:1 (2+1)

Course objectives:

To impart knowledge on

1. Agriculture Finance and Indian financial institutions purveying agricultural credit in India.
2. Structure, functions and services of commercial banks and non-banking financial institutions in India.
3. Historic and contemporary role of cooperatives and their contribution to farming community.

Course Outcomes:

On completion of this course, students will be able to

1. Understand financial system in India.
2. Apply principles of banking and credit appraisal procedure.

3. Analyze credit and deposit services of private, public and cooperative sector banks.
4. Prepare and analyze Balance Sheet, Income, and Expenditure Statements of a business unit.
5. Develop skills in credit analysis, dealing with bankers, loan application procedures.
6. Popularize farmer-friendly schemes of Crop insurance and Cooperative warehousing among farmers.

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, World Bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent developments in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms – SWOT analysis. Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

Practical

Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business – A case study. Preparation and analysis of balance sheet-A case study. Preparation and analysis of income statement – A case study. Appraisal of a loan proposal- A case study. Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value-added products.

References

1. Reddy, S. and Ram, P.R.2005. *Agricultural Finance and Management*. Oxford and IBH, Publishers, New Delhi.
2. Reddy, S., Raghuram, P., Neelakantan,T.V and Bhavani, D.I. 2004. *Agricultural Economics*. Oxford and IBH Publishers, New Delhi.
3. RBI: <https://www.rbi.org.in>
4. NABARD: <https://www.nabard.org>
5. World Bank: <http://www.worldbank.org>
6. ADB: <http://www.adb.org>
7. Lead Bank: <http://www.canarabank.com>

21AG2053 AGRICULTURAL MARKETING TRADE & PRICES

Credits: 2:0:1 (2+1)

Course objectives:

To impart knowledge on

1. Market structure and its classification
2. The theories of demand and supply of agricultural produce in market-oriented economy
3. Grading, packing, branding, labelling (AGMARK) of agricultural produce

Course Outcomes:

On completion of this course, students will be able to

1. Know the contours of agricultural market ecosystem, different market structures and their functions.
2. Analyze the demand and supply problems in agricultural marketing systems, marketing efficiency and policies.
3. Demonstrate the methods of valuation of farm assets
4. Understand the food supply chain and its actors and activities.
5. Gain practical skills on dealing with marketing institutions and warehouses.
6. Understand international trade arrangements under WTO, Agreement on Agriculture (AOA) and EXIM policies.

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri-commodities: nature and Concept of risk and uncertainty in agriculture production, nature and sources of risks and its management strategies, Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Producer's surplus – meaning and its types, marketable

and marketed surplus, factors affecting marketable surplus of agri-commodities; Marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing; Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; marketing management - product life cycle (PLC) and competitive strategies: meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

Practical

Plotting and study of demand and supply Market curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

References

1. Philip, K. 2004. Marketing Management. Prentice Hall, New Delhi.
2. Philip, K. 2004. Principles of Marketing. Prentice Hall, New Delhi.
3. Acharya, S.S and Agarwal. N L. 2019. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Alagumani, T., Chinnaiyan, P. and Elangovan, S. 1998. Agricultural Management. K9 International, Madurai.

21AG2054 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS COMMUNICATION

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Entrepreneurial spirit and orientation towards becoming an entrepreneur
2. Agri-business opportunities that are commercially successful and the procedures involved in start-ups
3. The art and science of business plan and project formulation

Course Outcomes:

On completion of this course, students will be able to

1. Distinguish different entrepreneurial traits and skills
2. Know the agribusiness opportunities open for agriculture graduates
3. Apply the leadership skills to get financial support for start-ups
4. Understand the impact of economic reforms in agri-business
5. Perform SWOT analysis of an entity for any prospective agribusiness/ideas
6. Formulate business proposals for successful implementation of business plans

Theory

Concept of entrepreneur, entrepreneurship development, Characteristics of entrepreneurs; SWOT Analysis and achievement motivation. Government policy, programs, and institutions for entrepreneurship development. Impact of economic reforms on Agribusiness/ Agri-enterprises, entrepreneurial development process; Business leadership skills; developing organizational skill (controlling, supervising, problem solving, monitoring and evaluation), developing managerial skills, business leadership skills (communication, direction and motivation skills), problem solving skill, supply chain management and total quality management, project planning formulation and report preparation. Financing of enterprise opportunities for agri entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem-solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea. Preparation of business plan and proposal writing. Visit to local rural enterprise engaged in agribusiness (Agri out based based), Visit to local rural enterprise engaged in agribusiness (Agri input based) Art of raising fixed and working capital for the business - Interaction with bank managers funding entrepreneurs and agribusinesses. Visit to entrepreneurship development institute and studying their promotional activities.

References

1. Chopra, R.R., P.S. Kapse and P.R. Deshmukh. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur, India.
2. Singal, R.K. 2006. Entrepreneurship Development and Management. S. K. Kataria and sons, New Delhi, India.
3. Nandan, H. 2013. Fundamentals of Entrepreneurship. PHI publishers, New Delhi, India.
4. Sangeeta Sharma, 2016. Entrepreneurship Development. PHI Publishers, New Delhi.
5. Heady Earl, O and H. R. Jenson, 1954. Farm Management Economics. Prentice Hall, New Delhi.
6. Johl, S.S. and J.R. Kapur. 2006. Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi.
7. Karan Singh and A S. Kahlon 1981. Economics of Farm Management in India. Theory and Practice. Allied Publishers Pvt. Ltd, New Delhi.
8. Prasad. L.M. 2001. Principles and Practices of Management. 9th Ed. S. Chand and Sons, New Delhi.
9. Koontz Harold and Weihrich, Heinz, 2007. Essentials of. Management. Tata McGraw Hills, Education Private Limited, New Delhi.

21AG2055 FARM MANAGEMENT, PRODUCTION & RESOURCE ECONOMICS

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The concepts and the principles of farm management and production economics.
2. The economic principles/theory underlying resource allocation and decision- making process.
3. The application of economic principles in organizing and managing businesses with special emphasis on optimal enterprise combinations to meet household goals.

Course Outcomes:

On completion of this course, students will be able to

1. Discuss the concepts and principles of farm management and production economics.
2. Demonstrate the optimum use of capital, labor and land by recalling when, where and how to produce principles.
3. Discuss the management of resources during crop production, livestock and allied enterprises.
4. Apply economic principles towards farm management.
5. Plan optimal enterprise combinations to meet household goals.
6. Analyze farm business, collect and analyze data on various resources.

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms. Principles of farm management: concept of production function and its type, use of production function in decision- making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labour income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies, Crop/livestock/machinery insurance –weather-based crop insurance, features, determinants of compensation. Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources. Positive

and negative externalities in agriculture, Inefficiency and welfare loss, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India.

References

1. Raju, V.T. and Rao, D.V.S, (2014) Economics of Farm Production and Management"
2. Dewett, K.K. (2005). Modern Economic Theory. S. Chand, New Delhi.
3. Sharma. et. al., (2014) Practicals in Agricultural Economics, Daya Publishing House.
4. Chavan, U.D. et. al., (2015) Key Notes on Agricultural Economics, Business Management and Statistics (PB), Daya Publishing House

21AG2102 RURAL SOCIOLOGY & EDUCATIONAL PSYCHOLOGY

Credits: 2:0:0 (2+0)

Course objectives:

To impart knowledge on

1. Sociological behaviour of rural population
2. Functions of rural society social stratification and social changes
3. Behavioral pattern and theories of motivation

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic concepts of rural sociology
2. Remember the significance of rural sociology in agricultural extension
3. Analyze the pattern of behavioral changes of rural society under critical circumstances
4. Apply the concepts of educational psychology in agriculture
5. Apply knowledge on functions of social institutions
6. Adopt the concept of agricultural extension practices in day today life of farmers

Theory

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

References

1. Desai, A.R. 2003. *Rural sociology in India*. Popular Prakasan, Bombay.
2. Parthasarathi De., 2012. *Rural Sociology*. Pearson Education, New Delhi
3. Samanta, R.K. and Arora, S.K. (Eds). 1997. *An introduction to Sociology*. Kitab Mahal. S.D., Pvt. Ltd. Allahabad

21AG2103 FUNDAMENTALS OF AGRICULTURAL EXTENSION EDUCATION

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The concept of extension education and its importance in Agriculture development
2. Various rural development programs aimed at poverty alleviation and to increase employment opportunities and their analysis
3. The new innovations being brought into the Agricultural Extension in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand agricultural extension and rural development programs
2. Create employment opportunity based on the knowledge gained on different schemes operated by state and central governments.
3. Remember the new innovations in the area of agricultural extension in India
4. Apply the practical knowledge gained on technology transfer from lab to land.

5. Create awareness among farmers on different communication technology and journals available for scientific farming
6. Apply the Knowledge for uplifting poor and marginal farmers

Theory

Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Program planning- Meaning, Process, Principles and Steps in Program Development. Extension systems in India: extension efforts in pre- independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development Programs launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND,NATP, NAIP, etc.). New trends in agriculture extension: privatization extension, cyber extension/ e- extension, market-led extension, farmer-led extension, expert systems, etc. Rural Development: concept, meaning, definition; various rural development Programs launched by Govt. of India. Community Dev - meaning, definition, concept & principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension Programs; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; handling and use of audio visual equipments and digital camera and LCD projector; preparation and use of AV aids, preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA and other development departments at district level; visit to NGO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; exposure to mass media: visit to community radio and television studio for understanding the process of Program production; script writing, writing for print and electronic media, developing script for radio and television.

References

1. De, Dipak. 2011. *A handbook of Extension education*. JV Publishing House, Jodhpur
2. Van Den Ban, A.W. and Hawkins, H.S. 1998. *Agricultural Extension* (2nd Ed). New Delhi, CBS Publishers and Distributors.
3. Vasanth Kumar, J. 2007. New Dimensions and approaches in Extension Pluralism for Rural Development. J.V. Publishing House, Jodhpur.
4. www.planning commission.nic.in
5. www.agricoop.nic.in
6. www.rural.nic.in

21AG2104 EDUCATIONAL TOUR – I

Credits 0:0:1 (0+1)

Course Objectives:

To impart knowledge on

1. Functioning of agricultural research institutions throughout the state
2. On-going agricultural research and extension programs
3. Region specific crop production technologies

Course Outcomes:

On completion of this course, students will be able to

1. Categorize agricultural crops grown in the different agro climatic zones of Tamil Nadu.
2. Remember different agro-climatic zones of Tamil Nadu
3. Distinguish social, cultural and economic differences in various agricultural zones.
4. Compare and contrast the different soil types and cropping systems in Tamil Nadu.
5. Recommend climate and region-specific cultivation practices.
6. Analyze different rainfall patterns of different agro-climatic zones of Tamil Nadu

Practical

The study tour Program is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution. In the study tour Program, full attendance is mandatory for a pass as per the ICAR regulations. The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

21AG2105 EDUCATION TOUR – II

Credits 0:0:1 (0+1)

Course Objectives:

To impart knowledge on

1. The various crops and cropping systems of South India.
2. The various agricultural and agro-based institutions/ Research Stations/ Colleges in South India
3. The ongoing agricultural research and extension programs implemented by the Government and the State Agricultural Universities

Course Outcomes:

On completion of this course, students will be able to

1. Identify the various crops across the states of South India
2. Discuss the cropping systems practiced in the different agro-climatic zones of South India
3. Describe the soils, irrigation practices, sources of irrigation and other farming related activities in different parts of their visit
4. Assess the scope of farming, agro-based industries and related activities across the states of South India.
5. Relate the social and cultural aspects of the people of different agricultural zones
6. Discuss the commercial operations of farming and related activities

Practical

The study tour Program is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour Program, full attendance is mandatory for a pass as per the ICAR regulations. The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

21AG2106 RURAL AGRICULTURAL WORK EXPERIENCE (RAWE) AND AGRO-INDUSTRIAL ATTACHMENT (AIA)

Credits 0:0:20 (0+20)

Introduction

The Honorable Prime Minister of India launched „Student READY“ Program on 25th July 2015. The term “READY” refers to “Rural Entrepreneurship Awareness Development Yojana”. To reorient graduates of agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the Program as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

There are two components:

- Rural Agricultural Work Experience (RAWE)
- Agro-Industrial Attachment and Plant Clinic (AIA)

The Rural Agricultural Work Experience (RAWE) helps the students primarily to understand the rural situations, status of agricultural technologies adopted by farmers, prioritize the farmer’s problems and to develop skills & attitude of working with farm families for overall development in rural area.

The students will undertake this program during the seventh/eighth semester for a maximum duration of 20 weeks with a weightage of 0+20 credit hours in two parts namely RAWE and AIA. RAWE will consist of general orientation and on campus training by different faculty members followed by village attachment/unit attachment in University/ College / KVK or a research station. Under AIA, the students would be attached with the agro-industries to get an experience of the industrial environment and working. Due weightage in terms of credit hours

will be given depending upon the duration of stay of students in villages/agro industries. At the end of RAWE & AIA, the students will be given one week for project report preparation, presentation and evaluation. The students would be required to record their observations in field and agro-industries on daily basis and will prepare their project report based on these observations.

RURAL AGRICULTURAL WORK EXPERIENCE (RAWE)

Credits: 0:0:16 (0+16)

Course Objectives:

To impart knowledge on

1. The socio-economic conditions of the farmers and their problems
2. Communication skills among students in using extension teaching methods for transfer of technology
3. The agro-industrial environment

Course Outcomes:

On completion of this course, students will be able to

1. Understand the agricultural ecosystem and farming systems
2. Acquaint themselves with farmers' problems and situations
3. Acquire knowledge on agricultural innovations through demonstrations and farmers' training/ field day arranged with help of agriculture extension officers
4. Know the government, private and NGO rural development activities carried out in villages
5. Know the procedure of undertaking socio-economic studies
6. Remember agro-industrial operations

Agro-Industrial Attachment (AIA)

Credits: 4 (0+4)

Technology and globalization are ushering an era of unprecedented change. The need and pressure for change and innovation is immense. To enrich the practical knowledge of the students, in-plant training shall be mandatory for students for a maximum period of up to 3 weeks. In this training, students will have to study a problem in industrial perspective and submit the reports to the college. Such in-plant trainings will provide an industrial exposure to the students as well as to develop their career in the high tech agro-industrial requirements. In-Plant training is meant to correlate theory and actual practices in the industries and plant clinic system.

Practical

Unit I: Rural Agricultural Work Experience (RAWE)

This unit enables the students to study of Village and Farm households (Agro-Ecological and Socio- Cultural Economic, Setting), particularly:

- Village settlement pattern, demography, climate, land utilization pattern, resources inventory, infrastructure facilities, rural institutions, organizations, groups, customs, beliefs and value systems.
- Study of cropping pattern, cropping systems, extent of adoption of latest technologies and constraints – cereals, millets, pulses, oilseeds and horticultural crops–productivity – Decline in productivity – Yield gap – constraints in production. Specific study on the following:
 1. Agronomic intervention.
 2. Plant protection intervention.
 3. Soil improvement intervention.
 4. Fruit and vegetable production intervention.
 5. Food processing and storage intervention.
 6. Animal production intervention.
- Understanding social participation, leadership pattern, scientific orientation and role of women and youth in agricultural development.
- Extension methods and audio-visual aids, practicing individual, group and mass contact methods.
- Studying the existing indigenous technical knowledge and its importance for technology generation.
- Understanding the communication pattern in villages.
- Studying farm women associations / farmers associations / commodity groups and learning their functioning and use of their services for dissemination.
- Conducting need-based skill demonstrations in the villages.
- Developing whole village development plan.
- Contacting individual farmers to assess the farming systems practiced by marginal, small, medium, big farmers and farm women.
- Preparation of individual farm plan.
- Documentation of success stories of the farmers.

- Study of University/ College/ KVK Research and Extension activities and Agricultural development schemes in the villages.

Unit II: Study of Agro-Industry & Plant Clinic

Industries to be studied include seed/sapling production, Pesticides: insecticides. Post-harvests: processing –value addition. Agri-finance institutions. Dairy, Poultry, etc.

- General information about the Agro-Industry – Nature of business – Brief history of the firm - Licensing and other legal aspects of the firm.
- Study of structure, functioning, objective and mandates of the industry.
- Study of various processing units and hands-on trainings under supervision of industry staff.
- Employment generated by the industry.
- Contribution of the industry-promoting environment.
- Acquaintance with functioning of Plant clinics.
- Learning business network including outlets of the industry.
- Skill development in all crucial task of the industry.
- Documentation of the activities and task performed by the students.
- Performance evaluation, appraisal and ranking of students.

RAWE Components and Activities:

	Activity	No. of weeks*	Credit Hours
Preparation	General orientation and On-campus training by different faculty members	1	
RAWE	Village Attachment (including Extension center)	8	14
	Unit Attachment in Univ./college/ KVK, Research station & NGO	5	
	Plant Clinic Attachment	2	2
	Agro-Industrial Attachment	3	4
Evaluation	Project Report Preparation, Presentation and Viva-Voce	1	
	Grand Total	20	20
*As per ICAR V Dean Committee Report , P:76			

Evaluation of student RAWE program

Students shall be evaluated component-wise under village attachment/ agro- industrial attachment.

The university will designate a RAWE program coordinator who along with Mentor-teachers for the students' groups would be become the committee of evaluators. While marking the performance, due weightage to the observations made by the farmers/ Agricultural Extension Worker / Scientists/Agro-industrial Officer and the program Coordinator with whom they are attached will be given. The students' will be evaluated for 100 marks. The outline of evaluation and distribution of marks will be as follows:

Components	Village Attachment	Extension Centre. Attachment	Univ./KV K/Research Station /NGO Attachment	Agro- Industry & Plant Clinic Attachment	Total Mark
Participation, Oral Presentation and Work Diary maintained	30	10	10	10	60
Preparation Report	10	5	5	5	25
Overall Exhibition**					15
Total	40	15	15	15	100

****Final display and exhibition of learning outputs/findings/visuals/charts/posters/ models before the evaluation Committee**

Note: Only one examination (end semester) will be conducted at end of the semester for 100 marks.

Performance during placement:

The committee led by the RAWE Coordinator and Mentor-teachers, who frequently visits /villages in rotation will assess the students' performance during the placements in villages. In case of placements in industries/institutions, the committee in consultation with the concerned designated person in the host institute will assign the marks for the performance of students.

Group Presentation and Viva-voce:

After completion of student's placements in rural areas and institutions/industries, the committee will have group discussion session to assess each student's level of participation and interaction abilities based on experience gained in RAWE. Each student along with the student groups to which he belongs will give a brief presentation on the work that has been carried out, experience gained and points for future consideration. A viva- voce examination will be conducted for each student on these relevant topics to know the overall impact of RAWE on the student, on the farming community and on the Institutions. Using the outputs and findings from various activities carried out in the filed Programs, the student groups shall put up a small exhibition/display to be seen, observed and scrutinized by the evaluation committee.

Attendance & diligence:

Marks are given for student's presence and attentiveness in classes conducted on the campus and placements in rural areas/institutions.

Work diary:

Evaluation of work diary indicating brief description of activities carried out by the student every day during the placements.

Practical record/Project report:

For each component, the student will maintain a practical record. The record will have detailed description for all the topics specified. The description will be on statement of tasks carried out, sequential steps/procedure followed in completion of the task, approaches used to accomplish the task, impact of the task on the intended audience, feedback obtained, and lessons learnt. For the courses where placements in other institutions/industries are made, the student will write report with description on background of the institution as per topics given in the syllabus. Since the credit hours allotted to the RAWE program are grade-based, the minimum condition of attendance and grading system will apply for the program as will be applicable to other courses.

It is expected that at the end of RAWE program, the students should gain familiarity and competency for working with rural stakeholders viz, farmers, development departments, agro-industries, NGOs and others. The evaluation committee must ensure percentage increase in this competency at the end and successful organization of all RAWE programs.

Monitoring & Coordination

For each batch, there will be a designated RAWE coordinator and concerned Mentor-teachers of the batch/student groups who will make periodical visits the rural- placement areas to guide, supervise and monitor the work of students as well as to evaluate the performance of the students on the concerned subject. They will also stay overnight once in a fortnight to support the students during the extension educational activities conducted during evening hours.

The RAWE coordinator in liaison with KVK/ZRS/NGO and other developmental departments will facilitate visit of mentor-teachers to villages after the return of the students to ensure continued technical support to farmers, till the 'end of crop season. The Dean/ HoD of the college will provide necessary resources-material, finance, man power, vehicles, etc. and ensure participation of the designated mentor- teachers in the RAWE activities. Coordination committee for RAWE may consist of:

1. Dean of the Faculty - Chairman
2. HOD, Agriculture - Convener
3. Senior Teacher of Extension Education- RAWE Coordinator
4. Student Counselor/Mentor- Member
5. Representative of State Dept. of Agriculture (AO) - Member
6. Village Leader / Farmer (off-campus representation - Member
7. Agro-industry Representative -Member
8. Group Facilitator (Student representatives) – Member

Other General Guidelines:

- The heads of departments will take up a mid-term appraisal and the evaluation committee for reviewing the work carried out by the students.
- Periodical visits will have to be made by evaluation committee members to the locations to monitor, guide and supervise the students.

- An exhibition will be conducted highlighting the experiential learning process, depicting the outcomes, supported with charts, posters, specimens, models, etc., on completion of the Program.
- Mass media coverage may be given for the different activities undertaken by the students. Local prominent persons may be invited for RAWE Programs in villages.
- Appropriate documentation has to be ensured at all stages. Photographs/video coverage and newspaper messages should be ensured and arranged in possible locations/events.

Instructions to students

1. No student should leave the location during this period on any account even during holidays.
2. A movement register will have to be maintained indicating the date, time, places, purposes of visit and expected time of arrival.
3. Students while leaving for respective villages/Agriculture Dept office/Industry should leave a message about their Program in the movement register maintained for this purpose where they are staying.
4. They should maintain an observation note for recording on the spot details during their visits to record daily activities and Programs.
5. All the students will be given a Practical Manual for which the details should be collected during the course of the Program.
6. On reaching the location of their stay, all students should intimate the Head of the Department / RAWE Coordinator and Mentor-Teacher about their arrival.
7. The RAWE Coordinator and Mentor-Teachers will guide the students about the villages identified for each student and details of the place of stay.
8. The Group Facilitators will guide the students in the selection of NGO, ADA office, and Agro-Industry for each group in and around the location.
9. All students should report to the Professor and Head, Department of Agriculture, RAWE-Coordinator and Mentor-Teachers and the Group Facilitators about the particulars regarding the villages allotted to them, the names and addresses of the contact farmer in the villages and work carried out every week.
10. Students should avoid unnecessary exchange of ideas with the local people on politics, religion, caste, etc., which will spoil the harmony of Program.
11. Students should contact maximum number of farmers in the locality and participate in the farm operations and record the observations about marginal, small and big farmers and one farm woman.
12. Students should avoid doing anything which may damage the image of students, as well as students' institution.
13. Head of the Department of Agri, RAWE Coordinator and Mentor -Teachers will make surprise inspection to know the students activities.
14. In case of emergency, students may contact Professor and Head, Department of Agricultural/ RAWE Coordinator/ Mentor-Teachers.
15. The mobile numbers of Group facilitators may be obtained by students.
16. The students should keep in readiness their observation note and Practical Manual for evaluation on the final day of RAWE.

References

1. ICAR Fifth Deans Committee Report, Agricultural Education Division, Indian Council of Agricultural Research (ICAR), New Delhi.
2. Academic Information HandBook, 2019, KITS, Coimbatore.
3. RAWE manual, guidelines of TNAU, Coimbatore.
4. Personal discussion with TNAU experts and brainstorming contribution from Agri. Faculty of KITS.

21AG2107 EXPERIENTIAL LEARNING PROGRAM (ELP)

(Module I and II)

Credits: 0:0:20 (0+20)

Experiential Learning Program (ELP) provides the students an excellent opportunity to develop analytical and entrepreneurial skills, and knowledge through meaningful hands-on experience, confidence in their ability to design and execute project work.

Students' Eligibility

To get the eligibility for registering for the EL program, the students should have completed all the courses successfully. No student should be allowed to take up the EL program with backlog/repeat courses. The assignment/allotment of the EL program shall be based on merit of the student at the end of 5th semester. A separate certificate should be issued to the students after successful completion of EL course. Allotment of EL programs amongst students to different modules should be done strictly on the basis of merit at the end of fifth semester.

Duration

The experiential learning program will be offered for 180 days (one semester) period in the final year. As the program is enterprise oriented, students and faculty are expected to attend the activities of the enterprise even on institutional holidays with total commitment, and without any time limit or restriction of working hours for ELP. The Experiential Learning Program shall be run for full year by making groups and rotating activities of the final year in two groups.

Attendance

The minimum attendance required for this program is 85%. The attendance of a student will be maintained at the EL unit. The attendance particulars shall be communicated to the Chief Executive Officer (Associate Dean) by the manager of the EL unit every week. The students will be eligible for the final evaluation of EL only when the attendance requirement is met with. Any student in the event of recording shortage of attendance has to re-register the EL when offered next by paying the assigned fee.

This program will be undertaken by the students preferably during the eighth semester for a total duration of 24 weeks with a weightage of 0:0:20 credit hours. The students will register for any of two modules, listed below, of 0:0:10 credit hours each.

ELP Module No	ELP Title
ELP 01	Seed Production Technology
ELP 02	Soil, Plant, and Water testing
ELP 03	Organic Production Technology
ELP 04	Commercial Floriculture and Landscaping
ELP 05	Commercial Nursery Management and Protected Cultivation
ELP 06	Production Technology for Bioagents and Biofertilizer
ELP 07	Mushroom Cultivation Technology
ELP 08	Commercial Beekeeping
ELP 09	Agribusiness management
ELP 10	Agricultural Information Support Services
ELP 11	Poultry Production Technology

Course Objectives:

To impart knowledge on

1. Thorough hands-on experience.
2. To work in project mode.
3. On enterprise management capabilities

Course Outcomes:

On completion of this course, students will be able to

1. Understand that learning and development are achieved through personally determined experience and involvement
2. Update their knowledge on principles of production technology, commercial agro technologies with current scenario and to impart entrepreneurial skill among students
3. Develop expertise in technology and entrepreneurial capacity by hands-on-training and practical exposure
4. Build their skills in project development and execution, decision making, individual and team co-ordination approach to problem solving
5. Acquire potential strengths through calibrated activities and enhanced participation
6. Analyze market demand and marketing strategies

ELP01: SEED PRODUCTION AND TECHNOLOGY

Planning of seed certification procedures, application for seed license, preparation of field map for registration and field layout, assessment of seed source, designing of planting ratio, seed upgradation, visit to seed certification department, sowing, field inspection, rouging operations, foliar application of nutrients, pollen management and assessment of seed set, visit to seed production plot. Pre-harvest sanitation spray, determination of maturity, harvesting, post-harvest verification, preparation of processing report. Drying, processing sequence, application for getting approval of seed processing unit, sampling and submission of samples, pre-storage seed treatments and packing, tagging, economics of seed production, visit to seed testing laboratory for seed testing, visit to private seed industry to study seed marketing network, seed export and import.

References

1. Agrawal, R.L. 2012. Seed Technology, Oxford & IBH Publishing Co., New Delhi.

2. Trivedi.R.K. and M. Gunasekaran. 2013. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.
3. Ramalingam, C., K. Sivasubramniam and A. Vijayakumar. 1997. A guide to seed legislation. Rasi Computers, Madurai.

ELP02: SOIL, PLANT AND WATER TESTING

Collection and preparation of soil, plant and irrigation water samples (sampling, processing and storing), estimation of pH, EC, organic carbon, available nitrogen, phosphorus, potassium and micronutrients – available Fe, Mn, Cu and Zn in soil, inferring the results and evaluating the fertility status of the soil.

Plant sample preparation for analysis, digestion of plant material and estimation of Nitrogen, Phosphorus and Potassium in plant. Determination of pH, EC, carbonate and bicarbonate, calcium, magnesium, sodium and potassium content in irrigation water. Computation of irrigation water quality, Residual Sodium Carbonate (RSC) and Sodium Absorption Ratio (SAR) of Irrigation water and evaluating the suitability of irrigation water.

References

1. Black, C.A. 1982. Methods of Soil Analysis, Part I ASA, Madison, USA.
2. Havlin, John, L., Tisdale, Samuel L., Nelson, Werner L., and Beaton James D. 2013. Soil Fertility and Fertilizers: An Introduction to Nutrient Management, 8th Edition, Pearson Education Inc., USA.
3. Hesse, P.R. 2002. A Textbook of Soil Chemical Analysis, CBS Publishers and distributors, Delhi
4. Muthuvel, P. and C. Udayasoorian. 1999. Soil, plant, water and agrochemical analysis, Tamil Nadu Agricultural University, Coimbatore, India.

ELP03: ORGANIC PRODUCTION TECHNOLOGY

Principles of composting. Various methods of composting. Characterization and preparation of quality compost material. Study of earthworms and methods of vermicomposting and preparation of bio-compost. Enriched compost and ITK based biological preparations. Visit to compost/vermicompost production unit. Preparation and use of bio-pesticides and bio-control agents. Quantification of nutrients from organic sources. Keeping quality - Application methods of manures and bio-fertilizers. Toxic residue analysis. Visit to bio-pesticides and bio-control production unit. Raising organic nursery and green manures for agricultural crops - Raising of crops organically by using organic inputs. Weed management – Nutrient management. Pest and disease management. Grading, packaging, post-harvest management and certification process. Visit to organic farms, organic farming outlets and certification agencies to study the standards & certification process.

References

1. Palaniappan S.P and K. Annadurai. 2018. Organic Farming: Theory and Practice. Scientific Publishers, Jodhpur, India.
2. Sharma A.K. 2008. Hand book of Organic Farming. Agrobios, India.
3. Panda H.. 2007. Biofertilizers and Organic Farming. Gene-Tech Books.
4. Parvatha Reddy P. 2010. Organic farming for sustainable Horticulture. Scientific Publishers, Jodhpur, India.
5. Tarafdar J.C., K. Tripathi and M. Kumar. 2009. Organic Agriculture. Scientific Publishers, Jodhpur, India.

ELP04: COMMERCIAL FLORICULTURE AND LANDSCAPING

Scope and importance of commercial floriculture in India. Preparation of land and layout. Production techniques of commercial flower crops for domestic and export market. Principles of protected structures – poly house – net house – shade net house. Growing of commercial flowers under protected structures. Postharvest technology of cut and loose flowers. Transportation for local and export market. Study of supply chain management and cold storage techniques. Dehydration techniques for drying of flower (identification of suitable species, drying and packaging). Making of different flower arrangements. Principles of landscaping- Study of different types and styles of gardens. Designing and planting for establishing different landscape gardens. Use of AutoCAD for designing gardens of different environments. Visit to different landscape like public, institutional, industrial and botanical gardens. Preparation of cost analysis.

References

1. Tiwari A.K. and R. Kumar. 2012. Fundamentals of ornamental horticulture and landscape gardening, New India Publishing Agency, Delhi
2. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana
3. Bose, T.K. R.G. Malti, R.S. Dhua and P. Das. 2004. Floriculture and Landscaping. Nayaprakash, Calcutta

4. Grewal H. S. and P. Singh. 2014. Landscape designing and ornamental plants. Kalyani publishers, New Delhi
5. De. L.C 2013. Nursery and landscaping. Pointer publishers, Jaipur, India
6. Roy R.K.. Fundamentals of Garden designing. 2013. New India publishing agency, Pitampura, New Delhi
7. Srivastava R. 2014. Fundamentals of Garden designing. Agrotech press, Jaipur, India.

ELP05: COMMERCIAL NURSERY MANAGEMENT AND PROTECTED CULTIVATION

Nursery production of fruit crops: Raising of rootstocks, grafting and budding of rootstocks, management of grafted plants, plant certification, packaging and marketing, quality control. Nursery production of ornamentals: Production of plantlets, production of potted plants, management and maintenance, sale and marketing. Protected cultivation of vegetables and flowers: Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing. Visit to commercial polyhouses, project preparation and planning. Specialized lectures by commercial export house. Study of designs of greenhouse structures for cultivation of crops. Land preparation and soil treatment. Planting and production: Visit to export houses: market intelligence, marketing of produce, cost analysis, institutional management. Report writing and viva-voce.

References

1. Sadhu, M.K. 1989. Plant Propagation. Wiley Eastern Ltd., New Delhi
2. Bose, T.K., S.K. Mitra, M. K. Sadhu and B. Mitra. 1991. Propagation of Tropical and Subtropical Horticultural crops. Naya Prakash Publishers, Culcutta, India.
3. Hartmann, H.T., D. E. Kester, F.T. Davies and R. L. Grene. 2010. Plant Propagation – Principles and Practices. Prentice Hall of India Private Ltd., New Delhi.
4. Nanda, K. K and V. K. Kochhar. 1995. Vegetative Propagation of Plants. Kalyani Publishers, Ludhiana.
5. Prasad, S. and U. Kumar. 2005. Green house management for horticultural crops. 2nd ed. Agrobios.
6. Resource book on Horticulture Nursery Management, National Agricultural Innovation Project, Indian Council of Agricultural Research, New Delhi.-110012.
7. Tiwari, G.N. 2003. Green house technology for controlled environment. Narosa Publ. House.
8. P. Ratha Krishnan (ed.). 2014. Plant nursery management: Principles and practices, Central Arid Zone Research institute, ICAR. Evergreen Printers, Jodhpurs

ELP 06: PRODUCTION TECHNOLOGY FOR BIOAGENTS AND BIOFERTILIZER

Rearing of host insect *Corcyra cephalonica*. Rearing of egg parasitoid- sterilizing the host eggs and parasitization, Tricho card preparation and storing. Rearing of larval parasitoid *Bracon* and *Goniozus nephantidis* – sandwich method. Mass production of predator *Chrysoperla carnea*. Isolation, characterization, screening and pure culture establishment of bio-fertilizers and bio-pesticides. Commercial mass production of bio-fertilizers and bio-pesticides. Quality analysis of bio-fertilizers and bio-pesticides. Testing the final product in small-scale level. Storage, marketing and cost analysis of bio-fertilizers and pesticides

References

1. Burges, H.D. 1981. Microbial control of pests and plant diseases, Academic Press, New York.
2. Clausen, C.P. 1940. Entomophagous insects. Hafner Publishing Co. New York.
3. DeBach. P. and E.T. Schlinger (eds.). 1964. Biological control of insect pests and weeds. Chapman and Hall, London.
4. Puri, S.N., K.S. Murthy and O.P. Sharma. 1997. Resource Inventory for Integrated Pest Management – I. Information Bulletin No. 3. National Centre for Integrated Pest Management (Indian Council of Agricultural Research), New Delhi
5. Garret, S.D. 1977. Pathogenic root infecting fungi. Cambridge unit press, Cambridge, p.294.
6. Hornby, D. 1990. Biological control of plant pathogens. Oxon, United Kingdom, CAB International, p.479.
7. Huffaker, C.B. (ed.) 1974. Biological control, Plenum Publishing Corporation. United States of America.
8. Puri, S.N., K.S. Murthy and O.P. Sharma. 1997. Resource Inventory for Integrated Pest Management – I. National Information Bulletin No.3.

ELP07: MUSHROOM CULTIVATION TECHNOLOGY

Students will learn the facilities required for construction of mushroom shed, cultivation room/structure and disinfection, maintenance of aseptic condition. Learn cultivation techniques for oyster mushroom: procurement of mother culture and spawn preparation - sterilization of straw- bed preparation – mushroom seeding – moisture maintenance – harvesting. Learn cultivation techniques for milky mushroom compost preparation and pasteurization - procurement of mother culture and spawn preparation - procurement of casing soil and preparation

for production -mushroom seeding - casing with soil and maintenance – harvesting. Visits to commercial mushroom production unit- Value added processing - Grading, packing - marketing and Cost economics of mushroom culture.

References

1. Agarwal, R.K. and C.L.Jandaik.1986. Mushroom cultivation in India. Indian Mushroom Growers Association, Solan, Himachal Pradesh.p-83.
2. Bahl, N.1988. Hand book of Mushroom II Edn. Oxford & IBM Publishing Co. New Delhi.
3. Marimuthu, T., A.S Krishnamoorthy, K.Sivaprakasam and R.Jeyarajan, 1989.Oyster Mushroom Production. The Vijay Books.Sivakasi, India.P.57.
4. A.S Krishnamoorthy, Marimuthu, T., and S. Nakkeran. 2005. Mushroom Biotechnology, The Vijay Books. Sivakasi, India.,Pub.ODL, TNAU, Cbe-3
5. Pathak,V.N. N.Yadav and M Gaur.2000.Mushroom production and processing Technology. Agribios (India) Ltd., New Delhi

ELP08: COMMERCIAL BEEKEEPING

Familiarization with different honeybee species and different castes. Handling of frames with colonies. Identification of bee flora - propagation of bee plants - preparation of floral calendar - hiving feral Indian bee colony, site selection for apiary. Visit to migratory bee keeping sites and commercial *cerana* bee farm. Visit to manufacturing unit (Marthandam). Visit to beekeeping society. Visit to honey processing unit. Colony inspection, maintenance - writing up of inspection report. Identification of queen, drone and brood cells - Sugar feeding of colonies in scarcity period - Identification of swarming tendency in a colony. Removal of Drone cells - maintenance of hive record -Management in honey flow season, dearth period, management of swarming absconding and laying workers -Practicing the methods of multiplication of bee colonies - Dividing, uniting bee colonies - Disease management - Identification of symptoms of Nosema. Sac brood Virus, Thai sac brood virus, American foul brood and European foul brood diseases - Preventive and control measures of the diseases- Application of antibiotics to colonies –Practicing the disinfection of frames - Natural enemies and predators of Honey Bees and their management. Migratory Bee Keeping - measures to be taken while transporting colonies - Mapping of areas for migration. Extraction of honey using honey extractor - moisture reduction - packing and storing of honey- methods of extraction of bees wax, royal jelly and bee venom. Marketing and working out of economics of honey and bee products - Preparation of bee keeping and honey processing unit project proposal to a bank or government authorities - Honey testing kit - physical and chemical methods of analysis - Visit to AGMARK laboratory.

References

1. Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Books.
2. Abrol, D.P. 2011. Beekeeping- A comprehensive guide to bees and beekeeping. Scientific publishers. Jodhpur.
3. SuganyaKanna, S., T. Senguttuvan and P. Karthik. 2019. Management of beneficial and harmful insects. Guru publishers, Trichy.
4. David Cramp, 2012. The Complete Step-by-step Book of Beekeeping: A Practical Guide to Beekeeping, from Setting up a Colony to Hive Management and Harvesting the Honey. Lorenz Books. London.

ELP 09: AGRI-BUSINESS MANAGEMENT

Students will learn about Agribusiness landscape in India – (Economic –Political – Institutional Ecosystem for Agribusiness). Hands-on experience in conducting market survey to gain understanding on working out consumer profile, competitors, substitutes and their price, and features, and designing market strategy (off-campus). Students will interact with staff / experts for mid-term corrections and submission of interim report (on campus). Students will acquire practical knowledge on forecasting market demand, pricing methods, creating and organizing advertising campaigns (Facebook ads, twitter ads, etc.). Product management: Various packaging materials used for agro-based products, product distribution network, marketing cost and marketing planning process (off-campus). Practical knowledge will be given on management of Agro-Inputs by marketing, firm-Visit, government Institutional visits. Hands-on experience in commodity trading, marketing research and devising marketing strategies (app development), information system for new product development, options for extending product life cycle, and spot and online marketing (social media marketing via YouTube, Facebook, Twitter, Instagram, and Pinterest), Business Law and Ethics, and Export-import policies followed by agriculture marketing firms (off-campus). Preparation of a model project proposal (On-campus). Preparation of Financial Statements- Balance Sheet, Income statement, and cash flow statement.

References

1. Raju, V.T. and D.V.S. Rao. 2014. Economics of Farm Production and Management. Oxford and IBH Publishers, New Delhi
2. Dewett, K.K. 2005. Modern Economic Theory. S. Chand publishers, New Delhi.

3. Sharma, Pawan Kumar, Dwivedi, Sudhakar and Bhat Anil. 2014. Practicals in Agricultural Economics, Daya Publishing House,
4. New Delhi.
5. Patil J. V., H.R. Shnide, Chavan, and P.P. Pawan. 2015. Key Notes on Agricultural Economics, Business management and statistics, Astra e-book publication.

ELP10: AGRICULTURAL INFORMATION SUPPORT SERVICES

E-Agriculture and Use of ICT in Agriculture- practical applications, Online Agriculture Support Systems, online advertising and marketing tools, Smartphone Apps in Agriculture for farm advisor services, market price, postharvest management etc., Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System.

References

1. Dent J.B. 1979. Systems Simulation in Agriculture. Applied Science Publishers Ltd, London, U.K
2. Joe. J. Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
3. Lyn. Malone, Anita M. Palmer, Christine L. Vloghat and J. Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
4. Mahapatra SK. et al., 2019. Introductory Agri- Informatics. Jain Brothers, New Delhi
5. Oliver M. A. 2010. Geospatial Applications for Precision Agriculture Springer Publishers, London, U.K.
6. Pedersen S.M. and K.M. Lind, 2017. Precision Agriculture: Technology and Economic Perspectives. Springer Publishers, UK.
7. Stafford J. V.. 2007. Precision Agriculture '07. Wageningen Academic Publishers, The Netherlands.
8. Vanitha G and Kalpana M. 2011, Agro-Informatics. New India Publishing Agency, New Delhi
9. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
10. Handbook of Agriculture, 2018, ICAR, New Delhi.

ELP11: POULTRY PRODUCTION TECHNOLOGY

Project preparation and planning based on visit to commercial broiler and layer farms. Preparation of project module based on source of finance, market information, assessment of fixed and working capital requirements, identification of sources for procurement of chicks, feed and other raw materials. Setting up a broiler / layer farming unit with suitable necessities. Planning and execution of management practices of poultry farm viz. Site selection and preparation of poultry house, different housing regimes, fumigation, incubation, brooding, debeaking and sanitation, hatching of eggs, management of chicks, management of pullets and growers, management of layers, management of broilers, selection and culling, feed and feed formulation. Prevention and control of diseases: medication and vaccination. Biosecurity measures: processing of broilers, evaluation of egg for its quality, record maintenance, integration method of broilers marketing, marketing channels in broilers and layers. Economics of broiler and layer farming.

References

1. Banerjee, G.C. 2018. The Text Book of Animal Husbandry. Oxford Book Company, Calcutta.
2. Handbook of Animal Husbandry (2002), ICAR, New Delhi.
3. Sabel Guerrero-Legarreta. 2010. Handbook of Poultry Science and Technology. John Wiley & Sons, New York
4. Vegad J. L. 2018. Poultry Diseases A Guide for Farmers and Poultry Professionals. CBS Publishers & Distributors Pvt Ltd., New Delhi.
5. Weeks, C and A. Butterworth. 2004. Measuring and auditing broiler welfare. CABI Publishing, Oxford, U.K
6. Diseases of Poultry, 13th Edition, David E. Swayne (Editor-in-Chief), Wiley India Pvt. Ltd, New Delhi.
7. Burr Charles T. and H.O Stuart. 2011. Commercial Poultry Farming. Biotech Books India, New Delhi.
8. Satapathy D., A. Sharma, J.K. Paswan, S. Sarkar and T.K. Varun. 2017. Economic Broiler Farming: Scope and Limitations. Indian Farmer, 4(5), pp. 393-405.
9. Singh, A.K., M.P., Sagar and M. Chander. 2017. Constraints in Contract and Non-contract Broiler Farming Systems in Eastern Plain Zone of Uttar Pradesh. The Indian Journal of Veterinary Sciences and Biotechnology, 12, pp. 39-41.
10. Kumar R.K., G.R. Manjunatha and B. Chandra. 2017. Economic performance of Contract Broiler Farming. Indian Journal of Poultry Science, 52(2), pp. 217-221.
11. Karthikeyan, R. and V.R. Nedunchezian. 2013. Vertical integration paving way to organized retailing in Indian poultry industry. International Journal of Business and Management Invention 2(1): 39-46.

12. Sridharan, A. and R. Saravanan. 2013. A Study on motivating factors to enter into poultry farming with special reference to Suguna broiler contract farms in Coimbatore district. International Journal of Marketing, Financial Services & Management Research 2(4):109

21AG2152 PESTS OF CROPS AND STORED GRAINS AND THEIR MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Symptoms, damage and seasonal incidence of agricultural, horticultural and storage pests.
2. Fundamental principles and components of Insect Pest Management.
3. Importance of storage pest and management strategies to avoid losses.

Course Outcomes:

On completion of this course, students will be able to

1. Remember morphology and taxonomic characteristics of insect pests affecting crops and stored grains
2. Understand nature and type of damage by different arthropod pests in field, vegetable, fruit and plantation crops, ornamental crops, spices and condiments
3. Analyze factors influencing pest occurrence, distribution and control measures
4. Summarize factors affecting losses of stored grain,
5. Analyze the role of various factors in deterioration of grain and their management strategies
6. Recommend pest management measures to resource poor farmers

Theory

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice other important arthropod pests of various field crop, vegetable crop, fruit crop, plantation crops, ornamental crops, spices and condiments. Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; Plantation, gardens, Narcotics, spices & condiments. Identification of insect pests and Mites associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides application technique. Fumigation of grain store / godown. Identification of rodents and rodent control operations in godowns. Identification of birds and bird control operations in godowns. Determination of moisture content of grain. Methods of grain sampling under storage condition. Visit to Indian Storage Management and Research Institute, Hapur and Quality Laboratory, Department of Food., Delhi. Visit to nearest FCI godowns.

Suggested Reading

1. Dhaliwal, G. S. and Ramesh Arora. 2014. Integrated Pest Management: Concepts and Approaches, Kalyani Publication, New Delhi.
2. Muthukrishnan, N., N. Ganapathy, R. Nalini and R. Rajendran. 2005. Pest Management in Horticultural Crops. New Madura Publishers, Madurai, 325 pages.
3. Ragupathy, A. and R. Ayyasamy. 2013. A Guide on crop pests. Namrutha Publications, Chennai, 368 pages.
4. Ranjeet Kumar. 2017. Insect pests of stored grain, Apple Academic press, Canada, 394 pages.

21AG2153 MANAGEMENT OF BENEFICIAL INSECTS

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The importance of beneficial insects and their characteristics.
2. Mulberry cultivation and silkworm rearing using innovative techniques.
3. Bee keeping techniques and mass culturing of predators and parasitoids.

Course Outcomes:

On completion of this course, students will be able to

1. Explain the importance of beneficial insects.
2. Describe the morphology, biology and behaviour of beneficial insects.
3. Identify the common parasitoids and predators used in biological control.

4. Mass-multiply the natural enemies.
5. Rear silkworms applying innovative techniques.
6. Practice beekeeping for commercial purpose

Theory

Importance of beneficial Insects, Beekeeping and pollinators, bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Insect pests and diseases of honeybee. Role of pollinators in cross-pollinated plants. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection. Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac- products. Identification of major parasitoids and predators commonly being used in biological control. Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinator, weed killers and scavengers with their importance.

Practical

Honey bee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.

Reference

1. David B. Vasanthraj. Elements of Economic Entomology (1975)
2. K.N. Ragumoorthi, V. Balasubramani, M.R. Srinivasan, Natarajan. Insecta An Introduction. AE Publications (2014)
3. M. Madan Mohan Rao. An Introduction to Sericulture (2019), B.S. Publications

21AG2202 FUNDAMENTALS OF PLANT BREEDING

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Genetic diversity, inheritance and variation in crops
2. Different breeding methods in autogamous, allogamous and asexually propagated crops
3. Intellectual property rights, patenting, plant breeders and farmers rights.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic concepts of plant breeding and genetics.
2. Remember Origin and diversity of different crops, components of inheritance and variations
3. Apply the knowledge to develop high yielding crops with better quality
4. Produce varieties and hybrids with Host Plant resistance
5. Apply the protocols of Intellectual Property Rights and Patenting practically.
6. Analyze Plant Breeders and & Farmer's Rights for research and commercial seed production of high yielding crops

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility-genetic consequences, cultivar options. Domestication, acclimatization and introduction; centre of origin/diversity, components of genetic variation; heritability and genetic advance; genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; multiline concept. Concepts of population genetics and hardy-weinberg law, genetic basis and methods of breeding cross-pollinated crops, modes of selection. Population improvement schemes- ear to row method, modified ear to row, recurrent selection schemes, heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties, breeding methods in asexually propagated crops, clonal selection and hybridization. Maintenance of breeding records and data collection; wide hybridization and prebreeding; polyploidy in relation to plant breeding, mutation breeding-methods and uses; breeding for important biotic and abiotic stresses; biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding, intellectual property rights, patenting, plant breeders and & farmer's rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and cross-pollinated crops. Emasculation and hybridization techniques in self and cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

References

1. Acquaaah, G. 2007. Principles of Plant Genetics & Breeding. Blackwell Publishing Co., New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Gupta, S. K. 2005. Practical Plant Breeding. Agribios, Jodhpur.
5. Roy, D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House Pvt. Ltd., New Delhi.
6. Sharma, J. R. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing Co. Pvt. Ltd., New Delhi.
7. Simmonds, N.W. and J. Smartt. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
8. Singh, B. D. 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana.
9. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
10. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.
11. Singh, P. and Narayanam, S. S. 2009. Biometrical Techniques in Plant Breeding (4th Ed.). Kalyani Publishers, Ludhiana.
12. Singh, S. and Pawar, I. S. 2006. Genetic Bases and Methods of Plant Breeding. CBS Publishers, New Delhi.

21AG2203 PRINCIPLES OF SEED TECHNOLOGY

Credits 1:0:2 (1+2)

Course Objectives:

To impart knowledge on

1. Importance of seed and concepts of seed, its classification, certification, purity and Seed Act.
2. Foundation and certified seed production protocols and procedures of cereals, pulses, oilseeds, fodder and vegetable crops.
3. Seed storage, pest and disease control, seed distribution infrastructure and protocols in India.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of quality seed in agriculture production.
2. Distinguish types of seeds and know seed certification process.
3. Apply seed production techniques in cereals, pulses, and oilseeds, vegetable and forage seeds.
4. Describe seed structure and morphology, physical characteristics of seed.
5. Conduct varietal identification, seed quality assessments tests and seed treatments.
6. Remember the concepts in seed storage and seed marketing

Theory

Seed and seed technology: introduction, definition, its importance in increasing agricultural production. Difference between seed, grain, and concept of seed quality. Deterioration causes of crop varieties and their control. Maintenance of genetic purity during seed production. Genetic and agronomic principles of seed production. Different classes of seed and truthfully labeled seed. Seed certification, phases of certification. Procedure for seed certification, field inspection. Foundation and certified seed production of important cereals (Rice, wheat and maize), pulses (Cowpea, mung, urd, pigeonpea, field bean and soybean), oilseeds (Sesame, coconut, sunflower, groundnut), fodder (Guinea grass, napier grass and lucern), and vegetables (Bhendi, tomato, brinjal, chillies and cucurbitaceous vegetables). Seed Act and Seed Act enforcement. Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency, Central and State Seed Testing Laboratories. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Seed Bill 2004, and other issues related to seed quality regulation. Varietal identification through electrophoresis and biochemical tests. Synthetic seeds and terminator gene technology. Detection of genetically modified crops. Transgene contamination in non-GM crops, GM crops and organic seed production. Physiological and harvestable maturity. Seed dormancy, internal and external factors affecting dormancy in seeds. Seed drying. Seed processing and their steps. Seed treatment, its importance, methods of application. Seed packing. Seed sampling and testing. Seed storage: general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional

media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies. Participatory seed production and seed village concept.

Practical

Varietal identification through seed structure and morphology, physical characteristics of seed and biochemical tests. Germination test in field and horticultural crops. Quick viability test of field and horticultural crops. Seedling vigor tests. Seed sampling principles and procedures; Physical purity analysis of field and horticultural crops. Genetic purity test: Grow out test and electrophoresis. Roguing, field inspection and preparation of field inspection report. Seed production in major cereals, pulses, oilseeds and vegetable crops. Visit to seed testing laboratories, farms and seed processing plants.

References

1. Khare and Bhale, 2014. Seed Technology, Scientific Publishers, New Delhi.
2. Sharma, J.P. 2011. Quality Seed Production of Vegetable Crops Technological Interventions, Volume 2: Crop Specific Aspect. Kalyani Publishers, Ludhiana.
3. Agrawal, P.K. and M. Dadlani, 1995. Techniques in seed science and technology. South Asian Publishers, New Delhi.
4. Agrawal, R.L. 1996. Seed Technology. Oxford & IBH Publication Co., New Delhi.

21AG2204 CROP IMPROVEMENT – I (KHARIF CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Diversity, inheritance and genetic variations present in *kharif* crops
2. The different breeding methods in asexually propagated, self and cross pollinated *kharif* crops
3. Hybrid seed production techniques and ideotype concepts in *kharif* crops

Course Outcomes:

On completion of this course, students will be able to

1. Remember the origin and diversity of different crops,
2. Understand the components of inheritance and various crop improvement techniques
3. Understand different breeding techniques for the genetic improvement in *kharif* crops
4. Evaluate the adaptability, stability, Quality parameters, biotic and abiotic stress of various *kharif* crops
5. Utilize hybrid seed production techniques in cultivation of *kharif* crops
6. Design and layout field experiments to analyze the quality characters of donor parents

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeonpea, etc. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species; viz., Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Sesame, Caster, Cotton, Cowpea, Brinjal, Okra and Cucurbitaceous crops. Maintenance breeding of different *kharif* crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

References

1. Agarwal.P.K, 2017. Principles of Seed Technology. South Asian Publishers, New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Simmonds, N.W. and Smartt, J. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
5. Singh, B. D., 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana
6. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
7. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.

21AG2205 CROP IMPROVEMENT – II (*RABI* CROPS)

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Genetic diversity and center of origin for different *rabi* crops
2. Different breeding methods in asexually propagated, self and cross pollinated *rabi* crops
3. Hybrid seed production techniques and ideotype concepts in *rabi* crops

Course Outcomes:

On completion of this course, students will be able to

1. Remember the origin and diversity of different crops, components of inheritance and various crop improvement techniques
2. Understand different breeding techniques for the genetic improvement in *rabi* crops
3. Evaluate the adaptability, stability, quality parameters, biotic and abiotic stress of various *rabi* crops
4. Make use of hybrid seed production techniques in farming of *rabi* crops.
5. Analyze the tools for seed production
6. Apply knowledge to develop Climate resilient crop varieties

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fodder crops and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation; study of genetics of qualitative and quantitative characters; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology of *rabi* crops. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species namely Wheat, Chickpea, Field pea, Horse gram, Rapeseed, Mustard, Sunflower, Safflower, Potato, Berseem. Sugarcane, Tomato, Chilli, Onion; Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Rabi* crops; Estimation of heterosis, inbreeding depression and heritability; Layout offfield experiments; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops

References

1. Agarwal.P.K, 2017. Principles of Seed Technology. South Asian Publishers, New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Simmonds, N.W. and Smartt, J. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
5. Singh, B. D., 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana
6. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
7. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.

21AG2304 ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The natural resources- Renewable and Non renewable
2. The Ecosystem, Biodiversity, Environmental pollution and conservation aspects
3. The Natural and Man- made Disasters and their Management

Course Outcomes:

On completion of this course, students will be able to

1. Identify and distinguish the natural resources- Renewable and Non-renewable
2. Illustrate the concepts of ecosystem and biodiversity
3. Examine and solve environmental pollution issues
4. Plan the conservation strategies
5. Make use of Environmental legislation
6. Appraise the disaster management strategies

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer- pesticide problems, waterlogging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food web and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem. Grassland ecosystem. Desert ecosystem. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wild life conflicts. Endangered and endemic species of India.

Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, urban problems related to energy, Water conservation, rainwater harvesting and watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act.

Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Program. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management: Natural Disasters-Meaning and nature of natural disasters, there and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management-Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river,hill slopes, etc.

References

1. Ahluwalia, V.K and Malhotra, S. Environmental Science. 2006. Ane Books Pvt. Ltd. India
2. Banjerji, S.K. 1993. Environmental Chemistry. Prentice Hall of India Pvt. Ltd, New Delhi
3. Gupta, A.K. 2007. Methods in Environmental Analysis Water, Soil and Air. 2nd Edn. Published by AGROBIOS (India). Jodpur
4. Katal, K.and Satake, M.1990.Environmental Pollution. 2nd Edn. Anmol Publishers, New Delhi
5. Loomis, R.S and Corner, D.J. 1992. Crop Ecology, Productivity and Management in Agricultural Systems. Cambridge University Press Pandey, S.N and Misra, S.P.2011Environment and Ecology. Ane Books Pvt. Ltd. India

21AG2305 RENEWABLE ENERGY AND GREEN TECHNOLOGY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Concept of renewable energy.
2. The various green technology techniques.
3. Technical know-how on renewable energy measures.

Course Outcomes:

On completion of this course, students will be able to

1. Gain basic knowledge of Solar energy harvesting
2. Familiarize with different types of Solar energy gadgets
3. Understand the contributions of energy sources to agriculture
4. Remember different types of biogas production structures
5. Design renewable energy structures
6. Analyse the green energy techniques

Theory

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand-alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, working principle of wind power plant. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

References

1. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
2. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
3. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non-Conventional Energy Sources, Himanshu Publications.
5. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
6. Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.

21AG2306 MANURES, FERTILIZERS AND SOIL FERTILITYMANAGEMENT

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The properties and composition of organic manures and chemical fertilizers
2. The mechanism of nutrient transport in plant and soil, plant nutrient deficiency and toxicity symptoms.
3. Soil chemistry, soil fertility testing and plant nutrient analysis

Course Outcomes:

On completion of this course, students will be able to

1. Understand the properties of manures, fertilizers and soil amendments
2. Summarize the concepts of soil fertility and plant nutrition and chemistry of nutrients in soil.
3. Apply the concept of Integrated Nutrient Management and fertilizer recommendation practices
4. Evaluate the fertility of soil
5. Analyze plant nutrient content
6. Recommend fertilizer dosage for different soil types

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/green leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management. Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic

fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, Nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order. Soil fertility concepts and approaches. Soil fertility evaluation – visual, chemical – plant and soil test. Biological methods (Indicator plants and microorganisms) and DRIS. Soil test-based fertilizer recommendation, STCR, SSNM. History of soil fertility and plant nutrition. Criteria of essentiality. Role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, and rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions. Applications of advanced techniques in fertilizer recommendation and application – Remote sensing, GIS, GPS, precision agriculture, Big data and cloud computing.

Practical

Methods of fertilizer and manure sampling for analysis. Introduction to analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of soil organic carbon, Estimation of alkaline hydrolysable Nitrogen in soils. Estimation of soil extractable Phosphorus. Estimation of exchangeable potassium, Calcium and Magnesium in soils. Estimation of soil extractable S. Estimation of DTPA extractable Fe, Mn, Cu and Zn in soils. Estimation of Nitrogen, Phosphorus, Potassium and Sulphur in plants.

References

1. John L. Havlin, L. Samuel Tisdale, L. Werner Nelson and J.D Beaton. 2016. Soil Fertility and Fertilizers 8th Edn.. Pearson Publishers. London.
2. Kolay, A.K. 2007. Manures and Fertilizers. Atlantic Publishers & Distributors (P) Ltd., Chennai.
3. Millar, C. E. 1959. Soil Fertility. John Wiley Publishers, New York
4. Panda, S.C. 2017. Soil Fertility and Nutrient Management. Agrobios (India) Publishers, Jodhpur.
5. Yawalkar, K.S., J.P. Agarwal and S. Bokde. 2002. Manures and Fertilizers (9th Edition). Agri-Horticultural Publishing House, Nagpur- 440010, India.
6. <http://ecoursesonline.iasri.res.in/Courses/ManuresFertilizers&Agrochemicals/SSAC222/>
7. <https://www.pdfdrive.com/principles-and-practice-of-soil-science-the-soil-as-a-natural-resource/>

21AG2307 PROBLEMATIC SOILS AND THEIR MANAGEMENT

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. Soil health and irrigation water quality parameters.
2. Reclamation and management of problem soils.
3. Remote sensing, GIS, land use pattern and soil classification.

Course Outcomes:

On completion of this course, students will be able to

1. Understand soil quality and their categories.
2. Distinguish problematic soils.
3. Describe irrigation water quality standards.
4. Apply soil reclamation practices for saline, sodic and acid soils.
5. Understand remote sensing, GIS and bioremediation procedures.
6. Identify land use patterns.

Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Their categorization based on properties. Reclamation and management of Saline and sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils. Irrigation water – quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils. Multipurpose tree species, bio remediation through MPTs of soils, land capability and classification, land suitability classification. Problematic soils under different Agro-ecosystems.

References

1. Donahu, L. R., Miller, W. R. and Shickuluna, 1977. Soils. Prentice Hall of India Pvt. Ltd., New Delhi Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI New Delhi, 2002
2. William F. Bleam Soil and Environmental Chemistry (Second Edition) UW Madison, Department of Soil Science, Madison, WI, United States. Elsevier Inc. (Available Online)
3. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. 1982. Saline Alkali Soils of India, ICAR, New Delhi.
4. Biswas, T.D. and Mukharjee, S.K. 2001. Text Book of Soil Science, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

21AG2352 DISEASES OF FIELD AND HORTICULTURAL CROPS AND THEIR MANAGEMENT - I

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The various diseases of field and horticultural crops and their casual organisms
2. The symptoms associated with the disease and to understand the etiology and disease cycle
3. The different integrated practices to be followed for the management of plant pathogens

Course Outcomes:

On completion of this course, students will be able to

1. Recall various plant pathological terms and basic concepts of important plant diseases
2. Explain the disease symptoms of various plant diseases of field and horticultural crops
3. Interpret the host pathogen interaction on disease development in field and horticultural crops
4. Determine the prevalence, epidemiology and factors affecting disease development
5. Apply integrated management practices to control diseases of field and horticultural crops
6. Recommend management practices to different diseases of different crop plants

Theory

Symptoms, etiology, disease cycle and management of major diseases of following crops: Field Crops: Rice: blast, brown spot, bacterial blight, sheath blight, false smut, khaira and tungro; Maize: stalk rots, downy mildew, leaf spots; Sorghum: smuts, grain mold and anthracnose, Bajra: downy mildew and ergot; Groundnut: early and late leaf spots, wilt. Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Finger millet: Blast and leaf spot; black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Castor: Phytophthora blight; Tobacco: black shank, black root rot and mosaic. Horticultural Crops: Guava: wilt and anthracnose; Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top; Papaya: foot rot, leaf curl and mosaic, Pomegranate: bacterial blight; Cruciferous vegetables: Alternaria leaf spot and 98 black rot; Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight; Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic; Okra: Yellow Vein Mosaic; Beans: anthracnose and bacterial blight; Ginger: soft rot; Colocasia: Phytophthora blight; Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Note: Students should submit 50 pressed and well mounted specimens.

References

1. Arjunan.G. Karthikeyan, G, Dinakaran, D. Raguchander, T. 1999 Diseases of horticultural Crops, AE Publications, Coimbatore.
2. Das Gupta M.K. and Mandel W.C.1989. Post-harvest pathogens of Perishables. Oxford and IBH Publishing Company, New Delhi.
3. Rangaswamy C.2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi.
4. Dasgupta, M.K. and Mandal, W.C. 1989. Post-harvest pathology of perishables. Oxford IBH publishing Co., New Delhi.
5. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York.
6. Chaube H.S and Pandhir 2005.Crop diseases and their management .Prentice hall of India Pvt. Ltd. New Delhi
7. Gupta V.K and Paul V.S 2004. Fungi and Plant diseases. Kalyani Publishers .New Delhi
8. Mehrota, R.S. 1980. Plant Pathology, Tata Mc Grow Mill Pub. Co., New Delhi, Prakasam, V., Valluvaparidasan, V., Raguchander, T. and K.Prabakar. 1997. Field crop diseases, AE Publication, Coimbatore.
9. Singh, R.S .1993. Plant Diseases, Oxford &IBH Publication, New Delhi.
10. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York.
11. Rangasawmi, G and Mahadevan, A. 1998. Diseases of crop Plants in India, Prentice Hall of India Pvt. Ltd., New Delhi

21AG2353 DISEASES OF FIELD AND HORTICULTURAL CROPS AND THEIR MANAGEMENT –

II

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Major diseases of field and horticultural crops
2. Casual organisms of plant diseases, etiology and disease cycle

3. Integrated farming practices to be followed for effective management of plant pathogens

Course Outcomes:

On completion of this course, students will be able to

1. Recall various plant pathological terms and basic concepts of important plant diseases
2. Explain the disease symptoms of various plant diseases of field and horticultural crops
3. Interpret the host pathogen interaction on disease development in field and horticultural crops
4. Determine the prevalence, epidemiology and factors affecting disease development
5. Apply the concept of integrated management practices to control diseases of field and horticultural crops
6. Recommend management practices for diseases of different crop plants

Theory

Symptoms, etiology, disease cycle and management of following diseases: Field Crops: Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and earcockle, Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng, Sunflower: Sclerotinia stem rot and Alternaria blight, Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot, Gram: wilt, grey mould and Ascochyta blight, Lentil: rust and wilt, Cotton: anthracnose, vascular wilt and blackarm, Pea: downy mildew, powdery mildew and rust.

Horticultural Crops: Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis; Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl. Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic; Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch and Stem phylum blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leafspot.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

Note: Students should submit 50 pressed and well-mounted specimens.

References

1. Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. Diseases of horticultural Crops, AE Publications, Coimbatore.
2. Das Gupta M.K. and W.C. Mandel. 1989. Post-harvest pathogens of Perishables. Oxford and IBH Publishing Company, New Delhi.
3. Rangaswamy, C. 2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi.
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6. Chaube H. S. and Pandhir. 2005. Crop diseases and their management. Prentice hall of India Pvt. Ltd. New Delhi
7. Gupta V.K and V.S. Paul. 2004. Fungi and Plant diseases. Kalyani Publishers. New Delhi
8. Mehrota, R.S. 1980. Plant Pathology, Tata Mc Graw Mill Pub. Co., New Delhi,
9. Prakasam, V., V. Valluvaparidasan, T. Raguchander, and K. Prabakar. 1997. Field crop diseases, AE Publication, Coimbatore.
10. Singh, R.S. 1993. Plant Diseases, Oxford & IBH Publication, New Delhi.
11. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York
12. Rangaswami, G and A. Mahadevan, 1998. Diseases of crop Plants in India, Prentice Hall of India Pvt. Ltd., New Delhi

21AG2354 PRINCIPLES OF INTEGRATED PEST AND DISEASE MANAGEMENT

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The various categories of economically important pest and diseases
2. The principles and methods of detection and diagnosis of pest and diseases
3. Integrated Pest and Disease Management practices

Course Outcomes:

On completion of this course, students will be able to

1. Relate and recall the important concepts and principles of Integrated pest and disease management practices
2. Summarize and illustrate the important pest and diseases of various crops

3. Remember damage symptoms and diagnose the pests/diseases
4. Formulate IPM strategies
5. Recommend pest and disease management practices to farmers
6. Monitor and predict pest and disease outbreak

Theory

Categories of insect pests and diseases, IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management. Survey surveillance and forecasting of Insect pest and diseases. Development and validation of IPM module. Implementation and impact of IPM (IPM module for Insect pest and disease. Safety issues in pesticide uses. Political, social and legal implication of IPM. Case histories of important IPM programs. Case histories of important IPM programs.

Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of *Trichoderma*, *Pseudomonas*, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agroecosystem) dynamics of a selected insect pest and diseases. Plan & assess preventive strategies (IPM module) and decision making. Crop monitoring attacked by insect, pest and diseases. Awareness campaign at farmers' fields.

References

1. Agrios, G. N. 2008. Plant Pathology, 5th edition, Academic Press, New York.
2. Nene, Y.L. and Thapliyal, P.N. 1998. Fungicides in plant disease control. Oxford and IBH publishing Co. Ltd., New Delhi.
3. Chattopadhyay, S.G. 1998. Principles and procedure of plant protection, Oxford and IBH publishing Co. Ltd., New Delhi.
4. Narayanasamy, P. 1997. Plant pathogens detections and disease control. Oxford and IBH publishing Co. Ltd., New Delhi.
5. Narayanasamy, P. 2011. Microbial plant pathogens detections and disease diagnosis Vol. I. Springer publication.
6. Nagarajan 1983. Dynamics of plant disease. Allied publishers, New Delhi.
7. Dinakaran, D, Arjunan, G and Karthikeyan, G. 2003. Biological control of crop diseases
8. Prakasam, V., T. Raguchander and K. Prabakar, 2006. Applied Plant Pathology, A.E. publications, Coimbatore.
9. Cooke, B.M, Jones, D.G and Kaye, B. 2006. The Epidemiology of plant Diseases. Published by Springer, The Netherlands
10. Awasthi, V.B. 2007. *Agricultural Insect Pests and their Control*, Scientific publishers (India), Jodhpur, 267p. {ISBN:81-7233-491-5}
11. Dhaliwal, G.S. and Ramesh Arora. 2004. *Integrated pest management Concepts and Approaches*, Kalyani Publishers, Ludhiana, 427p. {ISBN:81-7663-904-4}
12. Regupathy, A. and R. Ayyasamy. 2013. *A Guide on Crop Pests*. Namrutha Publications, Chennai, 368 p. {ISBN:978-81-921477-1-0}
13. Srivastava, K.P. and G.S. Dhaliwal. 2011. *A textbook of Applied Entomology*. Vol. II, Kalyani Publishers, Ludhiana. 368p. {ISBN:978-81-272-6752-0}
14. Agrios, G.N. 2005. Plant Pathology – (5th Edition). Academic Press, New York
15. Pal, K. K. and B. McSpadden Gardener, 2006. Biological Control of Plant Pathogens. *The Plant Health Instructor* DOI: 10.1094/PHI-A-2006-1117-02.APS Net
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17. Cooke, B.M, Jones, D.G and Kaye, B. 2006. The Epidemiology of plant Diseases. Published by Springer, The Netherlands

21AG2401 LIVESTOCK AND POULTRY MANAGEMENT

Credits 3:0:1 (3+1)

Course objectives:

To impart knowledge on

1. Importance of farm animals and Characters of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry.
2. Improvement of farm animal and poultry and disease control.
3. Management of farm animals, its nutrient and housing requirement.

Course Outcomes:

On completion of this course, students will be able to

1. Know the importance of farm animals and its influence in rural economy
2. Distinguish characteristics of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry.
3. Select quality breeds and poultry and improve livestock in a farm.
4. Choose nutritious feed rations and feed animals and poultry.
5. Set up proper housing for the farm animal and poultry.
6. Manage farm animal diseases, young ones and their products – milk, meat and egg.

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breed of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipments. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

References

1. Banerjee, G.C. 2018. A Text Book of Animal Husbandry (8th Edn.). Oxford Book Company, Calcutta.
2. Sastry, N.S.R., Thomas, C.K. 2005. Livestock Production Management. Kalyani Publishers, Ludhiana
3. Sarvajeet Y., 2016. Advances in Sheep and Goat production and management.
4. D U P Vigyan Vishwa vidyalaya. Evam Go Anusandhan Sansthan Mathura, India
5. ICAR (2002) Handbook of Animal Husbandry, ICAR, New Delhi.
6. Vegad J. L. 2018. Poultry Diseases A Guide for Farmers and Poultry Professionals. CBS Publishers & Distributors Pvt Ltd., New Delhi.

21AG2452 FARM MACHINERY AND POWER

Credits 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. Status of farm power in India
2. Identification of components of implements
3. Working principles of farm equipments during field operations

Course Outcomes:

On completion of this course, students will be able to

1. Evaluate the components of IC engine
2. Demonstrate the working principles and maintenance of tractor
3. Demonstrate the working principle of tillage equipments and intercultivation equipments
4. Examine working of various sowing and planting equipments
5. Demonstrate the working principles of plant protection equipments
6. Demonstrate the working principles of harvesting and threshing equipments

Theory

Status of Farm Power in India, Sources of Farm Power , I.C. engines, working principles of I.C. engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and solved problems. Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication ,fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system: clutch, gear box, differential and final drive of a tractor, Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage implement, Implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practical

1. Study of different components of I.C. engine.
2. Learning of tractor driving,
3. Familiarization with operation of power tiller.
4. Familiarization with different types of primary and secondary tillage implements
5. Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter
6. Familiarization with different types of sprayers and dusters
7. Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

References

1. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributors, Delhi. 99, 1997.
2. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 2010.
3. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005
4. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi, 1996.
5. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

21AG2453 PROTECTED CULTIVATION AND SECONDARY AGRICULTURE

Credits 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. Basics of protectedcultivation
2. Various techniques involved in protectedcultivation
3. Technical know-how on secondaryagriculture

Course Outcomes:

On completion of this course, students will be able to

1. Plan and design low cost green houses
2. Predict the plant responses to greenhouse environment
3. Estimate the cost benefit economics of protected cultivation
4. Understand engineering properties of food materials
5. Explain the working of commercial grain dryers
6. Illustrate the material handling equipments

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Green house environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, typical applications, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis. Important engineering properties such as physical, thermal and aero & hydrodynamic properties of cereals, pulses and oilseed, their application in PHT equipment design and operation. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of green house equipments. Visit to various Post Harvest Laboratories. Determination of Moisture content of various grains by oven drying & infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

References

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2. Donell Hunt, 2013. Farm Power and Machinery Management. 10th edition. MedTec Publishers, New Delhi.
3. Jana, B. L., 2008. Precision Farming. AgroTech Publishing Academy.
4. Kali CharanSahu, 2008. Text Book of Remote Sensing and Geographical Information Systems. Atlantic Publishers and Distributors Pvt Ltd.
5. K. RadhaManohar and C. Ignathinathane. 2015. Greenhouse Technology and Management. 2nd edition. B. S. Publications.

21AG2551 AGRI INFORMATICS

Credit 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Application of IT in agriculture using computerized models
2. Precision agriculture using geospatial technology
3. Decision Support Systems (DSS) and soil information for agricultural applications

Course Outcomes:

On completion of this course, students will be able to

1. Understand use of information, communication and technology (ICT) in agriculture
2. Demonstrate use of GIS and GPS systems in precision agriculture
3. Develop computerized models to understand plant growth process.
4. Use smart phone in farm advisory farm pricing and post-harvest management.
5. Manage input requirements for crops and animals.
6. Use Agriculture Expert system and Soil Information Systems for a firm decision.

Theory

E-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer- controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Practical

Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of geospatial technology for generating valuable information for agriculture. Hands on decision support system. Preparation of contingent crop planning.

References

1. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
2. Adams, C.R. K.M. Band ford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Daryaganj, New Delhi.
3. Lyn. Malone, Anita M. Palmer, Christine L. VIoghat Jach Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
4. David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA
5. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
6. Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.

21AG2552 INTELLECTUAL PROPERTY RIGHTS

Credits 1:0:0 (1+0)

Course Objectives:

To impart knowledge on

1. Individual's rights to protect/patent inventions obtained in the process of project work.
2. Strategies to register inventions/designs, in India and abroad.
3. Patenting, copyright, trademark, designs and information Technology Act.

Course Outcomes:

On completion of this course, students will be able to

1. Understand GATT, WTO, TRIPs and WIPO for IPR protection
2. Know to acquire the patent and copyright for their innovative work
3. Remember plagiarism, which can be questioned legally
4. Explain UPOV and PPV & FR Act of India
5. Apply, Analyze and use ITK strategies
6. Achieve new innovative goals

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc. Types of Intellectual Property and legislations covering IPR in India: -Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, compulsory licensing, Patent Cooperation Treaty, Patent search and patent database. Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders' rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders. Convention on biological diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

References

1. V K Ahuja (2017) "Law Relating to Intellectual Property Rights"
2. R Radhakrishnan and S Balasubramanian (2008) "Intellectual Property Rights: Text and Cases"
3. Venkatraman, (2012) An Introduction to Intellectual Property Rights
4. Dr. B.L. Wadehra (2012) Law relating to Intellectual Property, Universal Law Publishing Co.

21HO1001 AGRO-METEOROLOGY AND CLIMATE CHANGE

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Agricultural meteorology and its role in crop production
2. Atmospheric weather variables, climatic factors and their measurements
3. Climate change and its effect on crop production

Course Outcomes:

On completion of this course, students will be able to

1. Understand the significance of agricultural meteorology, climate and weather
2. Explain the various atmospheric weather variables and its significance in crop production
3. Discuss crop weather relationships for efficient crop production
4. Acquire knowledge on weather forecasting techniques and effect of climate change on crop production
5. Describe artificial rainmaking, precipitation, monsoons and its importance in Indian Agriculture
6. Discuss global warming, and its effect on regional and national agriculture

Theory

Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought, weather disasters and their management atmospheric pollution and role of meteorology. Basics of weather forecasting. Climate change-causes. Global warming-causes and remote sensing. Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases. Atmospheric chemistry. Plants sense and respond to changes in CO₂ concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C3 and C4 species. Plant development affected by growth in elevated CO₂. Physiology of rising CO₂ on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO₂. Change in secondary metabolites and pest disease reaction of plants. The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

Practical

Site selection for Agro meteorology observatory; Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine

duration and solar radiation; Measurement of wind direction and speed and relative humidity; Study of weather forecasting and synoptic charts. Visit to meteorological observatory, Visit to IMD meteorological observatory- Lay out plan of standard meteorological observatory. Recording of air and soil temperature. Measurement of radiation and components, Measurement of rainfall-different types of rain gauges, Measurement of wind speed and direction and atmospheric humidity, recording of evaporation. Synoptic charts and weather reports, symbols, etc.

References

1. Srivastava K. and P. K. Tyagi, 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
2. Lenka, D. 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
3. Prasad Rao, G. S. L. H. V., 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Mavi H.S. and Graeme J. Tupper, 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
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9. Pattersen, S. 1958. Introduction to Meteorology. Mc. Graw Hill Book Co. Inc., New York
10. Tailor, J.T. 1967. Agricultural Climatology. Pergman Press Ltd., Headington Hill Hall, Oxford, England
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12. Mavi, H.S. 1985. Introduction to Agrometeorology. Oxford & IBH Publishing Co., New Delhi.

21HO1051 ECONOMICS AND MARKETING

Credits: 2:0:1 (2+1)

Course objectives:

To impart knowledge on

1. Concepts of agricultural market structure and its classification
2. Theories of demand and supply of agricultural produce in market-oriented economy
3. Marketing of agricultural produce and preparation of individual projects

Course Outcomes:

On completion of this course, students will be able to

1. Understand the consumption, demand and supply in agricultural economics
2. Recall the concepts of agricultural marketing
3. Identify the factors affecting the agricultural production
4. Understand the marketing margin and marketing functions
5. Apply the knowledge on market intelligence, SWOT analysis and financial crisis management
6. Prepare project proposals and project reports using techno – economic parameters

Theory

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engel's law of family expenditure – consumer's surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization. Merits and demerits. Laws of return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures. Gross Domestic Product (GDP) – Role of Horticultural sector in National GDP. Marketing- Definition, marketing process, need for marketing, role of marketing, marketing functions, classification of markets, marketing channels, price spread, marketing efficiency, integration, constraints in marketing of agricultural produce, market intelligence, bank norms, insurance, SWOT analysis, crisis management. Techno-economic parameters for preparation of projects and basic guidelines for preparation of project report.

Practical

Techno-economic parameters for preparation of project. Preparation of bankable projects for various agricultural products and its value-added products. Identification of marketing channel, calculation of price spread identification of market structure and visit to different markets.

References

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4. Dewett, K.K., Verma. 2004 Elementary Economic Theory. S.Chand, New Delhi
5. Jhingan, M.L.2001. Micro Economic Theory. Konark publishers, New Delhi
6. Subba Reddy. S. Raghu Ram. P. NeelaKanta Sastry. T.V. Bhavani Devi. I. 2008. Agricultural Economics (2ndEdn.). Oxford and IBH publishing Co Pvt Ltd, New Delhi
7. Acharya. S.S. 2019. Agricultural Marketing in India (7thEdn.). 2019. Oxford and IBH publishing Co Pvt Ltd, New Delhi

21HO1151 FUNDAMENTALS OF ENTOMOLOGY

Credits: 2:0:1 (2+1)

Course objectives:

To impart knowledge on

1. Insect morphology, anatomy and physiology
2. Insect ecology, classification of pesticides and concept of different pest management techniques
3. Study of insects systematics

Course Outcomes:

On completion of this course, students will be able to

1. Understand the insect external body parts and their modifications
2. Acquire knowledge on structure of various organ systems and their functions
3. Analyse the factors influencing pest occurrence
4. Understand the concept of different pest management techniques
5. Develop knowledge on different orders and families of agriculturally important pests
6. Analyse the pest management strategies

Theory

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouthparts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance.

Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control importance, hazards and limitations. Recent methods of pest control, repellents, anti feed ants, hormones, attractants and gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes. Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae. Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and

wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

References

1. Gullan, P. J. and Cranston, P. S. 2014. The insects: an outline of entomology. (8th Ed.) Wiley Blackwell
2. Metcalf, C. L. and Flint, W. P. 1973. Destructive and Useful Insects. Tata Mc Graw Hill Publishing Co. New Delhi.
3. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. 1979. General and Applied Entomology. Tata Mc Graw Hill Publishing Co. New Delhi.
4. Naumann, I. D. 1991. The Insects of Australia a text book of students and research workers Vol. I & II (2nd Ed.) Commonwealth Scientific and Industrial Research Organisation. Melbourne University Press.
5. Pant, N. C. and Ghai, S. 1973. Insects Physiology and Anatomy. I CAR. New Delhi, 332 p. 6. Richards, O. W. and Davies, R. G. 1977. Imms General Textbook of Entomology Vol. I Chapman and Hall, London.
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21HO1201 PRINCIPLES OF GENETICS AND CYTOGENETICS

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The fundamentals of mendelian inheritance and gene interactions
2. The concept of linkage and its determination, Chromosomal aberrations and ways to induce it.
3. Cytoplasmic inheritance and its applications, Genetic makeup of cell and the process and regulation of gene synthesis

Course Outcomes:

On completion of this course, students will be able to

1. Solve problems on Mendelian genetics
2. Construct gene map using linkage
3. Identify the type of aberrations and its usage in agriculture
4. Clarity on inducing mutation by artificial methods
5. Explain the central dogma of life
6. Adopt the knowledge of Cytoplasmic inheritance in breeding

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; special types of chromosomes. Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example. Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications, Use of haploids, dihaploids and doubled haploids in Genetics. Mutation, classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance. Genetic disorders. Nature, structure & replication of genetic material. Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope. Study of cell structure. Mitosis and Meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and crossover analysis (through two-point test cross and three point test cross data). Study on sex linked inheritance in Drosophila. Study of models on DNA and RNA structures.

References

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2. Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
3. Singh, B.D. 2000. Fundamentals of Genetics (6th Ed.). Kalyani Publishers, Ludhiana
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21HO1202 PRINCIPLES OF PLANT BREEDING

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Genetic diversity, inheritance and variation in crops
2. Different breeding methods in autogamous, allogamous and asexually propagated crops
3. Intellectual Property Rights, patenting, Plant Breeders and Farmers Rights.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic concepts of plant breeding and genetics.
2. Remember Origin and diversity of different crops, components of inheritance and variations
3. Apply the knowledge to develop high yielding crops with better quality
4. Produce varieties and hybrids with Host Plant resistance
5. Apply the protocols of Intellectual Property Rights and Patenting practically.
6. Analyze Plant Breeders and & Farmer's Rights for research and commercial seed production of high yielding crops

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility - genetic consequences, cultivar options. Domestication, Acclimatization and Introduction; Centres of origin/diversity, components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept. Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement Schemes- Ear to row method, Modified Ear to Row, recurrent selection schemes; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Maintenance of breeding records and data collection; Wide hybridization and prebreeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and cross-pollinated crops. Emasculation and hybridization techniques in self & cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

References

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2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
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9. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
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12. Singh, S. and Pawar, I. S. 2006. Genetic Bases and Methods of Plant Breeding. CBS Publishers, New Delhi.

21HO1251 FUNDAMENTALS OF HORTICULTURE

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The scope and importance of horticultural crops.
2. The production techniques of various horticultural crops.
3. Establishment of orchard and its management.

Course Outcomes:

On completion of this course, students will be able to

1. Explain the significance and scope of horticultural crops
2. Identify and describe the growth and development of various horticultural crops
3. Discuss the production of horticultural crops in the country and related imports and exports
4. Demonstrate the production techniques of horticultural crops
5. Plan the establishment of Orchard and its management
6. Practice Special horticultural operations and organic farming in these crops

Theory

Scope and importance, nutritive value - Classification of horticultural crops, area, production, exports and imports, agro-climatic zones of India - Nursery techniques and their management, Vegetable gardens, nutrition, kitchen garden and other types of gardens, Phases of growth and development - Factors affecting growth and development - Propagation of horticultural crops - Cutting and Layering - Grafting and Budding - Rootstock - scion relationships, Compatibility and incompatibility - Asexual propagation - Apomixis and Polyembryony - Orchard establishment - Principles, planning and layout of orchards - Planting systems and planting densities - Management of orchards - Intercultural operations, Principles objectives and types of pruning - training - Fruit set - carbon nitrogen relation, structure and process in relation to set and drop, factors affecting and measures to overcome drop - Bearing habit and Classification of bearing habits of fruit trees - Problems of unfruitfulness - internal factors, external factors - measures to overcome - Seedlessness in horticultural crops - significance and induction - Plant growth regulators - Water management - irrigation methods, merits and demerits - Weed management - Fertility management in horticultural crops-manures and fertilizers - Cropping systems, intercropping, multi-tier cropping - Rejuvenation of old orchards, top working and frame working - Production and practices for fruit, vegetable and floriculture crops - Principles of organic farming - Supply chain management.

Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage, Visit to Private and Govt. nursery and orchard.

References

1. Jitendra Singh, 2004. *Basic of horticulture*. Kalyani publishers, Ludhiana.
2. Kumar, N.1997. *Introduction to Horticulture*, Rajalakshmi Publication, Nagercoil, Tamil Nadu.

21HO1252 PRINCIPLES OF LANDSCAPE ARCHITECTURE

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Historical importance of gardens and various styles of gardens in India and other countries
2. Principles and elements of landscape gardens
3. Planning and designing of different landscape

Course Outcomes:

On completion of this course, students will be able to

1. Understand the historical importance of gardens in India
2. Describe the essential features of various styles of gardens

3. Apply Auto CAD and Arch CAD for the designing of garden components
4. Plan and implement the garden design for different types of landscape
5. Implement garden principles suitable for varied landscape
6. Understand and implement bio aesthetic plan for different geographical locations

Theory

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD and Arch CAD in designing gardens. Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc.. Elements of landscape gardens viz. tangible and intangible elements. Bio-aesthetic planning, definition, objectives. Planning and designing of home gardens, colonies, country planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydroelectric stations, river banks, play grounds, Gardens for places of religious importance viz. temples, churches, mosques, tombs etc. Importance, features and establishment of English garden , Japanese gardens , Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens, Xeriscaping, definition, principles and practice.

Practical

Study of garden equipment. Study of Graphic language, Use of drawing equipment, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using Auto-cad/ archi-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, temples, churches, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

References

1. Tiwari, A. K. and R. Kumar. 2012. Fundamentals of ornamental horticulture and landscape gardening. New India.
2. Grewal, H.S. and P. Singh. 2014. Landscape designing and ornamental plants
3. R.K. Roy. 2013. Fundamentals of Garden designing. New India publishing agency, Pitampura, New Delhi.
4. Srivastava, R. 2014. Fundamentals of Garden designing. Agrotech press, Jaipur, New Delhi.
5. De, L.C. 2013. Nursery and landscaping. Pointer publishers, Jaipur India.
6. Bose, T.K. R.G. Malti, R.S. Dhua, and P. Das. 2004. Nayaprakash, Calcutta. Floriculture and Landscaping
7. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana.
8. Randhawa, G.S. and A. Mukhopadhyay 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi

21HO1253 PLANT PROPAGATION AND NURSERY MANAGEMENT

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Principles and tools involved in propagation of horticultural crops
2. The propagation structures and plant materials used in the multiplication of horticultural crops
3. Scope and techniques of micro-propagation in horticultural crops

Course Outcomes:

On completion of this course, students will be able to

1. Demonstrate propagation and nursery management techniques for horticultural crops
2. Describe various structures used for propagation
3. Select mother plant and prepare the propagation plant materials
4. Handle tools used in propagation and achieve skill-oriented knowledge
5. Manage nursery, maintain records, prepare young plants for propagation
6. Outline the micro-propagation techniques for horticultural crops

Theory

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification & stratification) internal and external factors, nursery techniques nursery management, apomixes – monoembryony, Polyembryony, chimera and bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot

beds, poly-houses, phytotrons nursery (tools and implements), and use of growth regulators in seed, types and stages of seed germination with examples. Vegetative propagation, methods and techniques of division- stolons, pseudo-bulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding physiological and bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micro-propagation – Micro-grafting, meristem culture, callus culture, anther culture, organogenesis, Soma clonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery. Cost of establishment of propagation structures.

Practical

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, grafting and budding including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery. Cost of establishment of propagation structures.

References

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8. Sarma, R.R.2002. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
9. Symmonds, 1996. Banana. II edition Longman, London.

21HO1254 TROPICAL AND SUBTROPICAL FRUITS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The scope and production details of tropical and subtropical fruits crops fruit crops in india
2. The physiology, characteristics and production techniques of these fruit crops.
3. The post-harvest management techniques involved in the preservation and processing of tropical and subtropical fruits crops

Course Outcomes:

On completion of this course, students will be able to

1. Explain the biology and classification of tropical and subtropical fruits crops
2. Identify the various tropical and subtropical fruit crops
3. Describe the specific production technology and cultural practices for each of these fruit crops
4. Identify the physiological disorders associated with these crops and their control measures
5. Explain production constraints
6. Demonstrate harvesting and post-harvest handling of tropical and subtropical fruits

Theory

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian,

rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Practical

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

References

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21HO1255 TROPICAL AND SUBTROPICAL VEGETABLES

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The scope, production, and economic importance of tropical and subtropical vegetable crops
2. The varieties, hybrids, cultivation and management aspects of tropical and subtropical vegetables
3. Cropping systems, postharvest management and economics of tropical and subtropical vegetable cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Remember the area, production and productivity of tropical and subtropical vegetables
2. Describe the characteristics of varieties, and hybrids of tropical and subtropical vegetable crops
3. Understand the importance of nutrient, weed and irrigation management in tropical and subtropical vegetable cultivation
4. Explain the package of practices of commercially important tropical and subtropical vegetables
5. Develop and maintain commercial vegetable nursery
6. Evaluate the various vegetable-based cropping systems and post-harvest handling of vegetable crops

Theory

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems water and weed management nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and subtropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

References

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19. Premnath, Sundari Velayudhan and Singh, D.P., 1987. Vegetables for the tropical region. ICAR.

21HO1270 PRODUCTION TECHNOLOGY FOR FRUIT AND PLANTATION CROPS

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Economic importance of fruit and plantation crops in India.
2. Production technology and cultivation methods of fruit and plantation crops.
3. Propagation methods in fruit and plantation crops.

Course Outcomes:

At the end of this course, the students will be able to:

1. Understand the scope and importance of fruit and plantation crop production
2. Apply propagation methods in fruit and plantation crops
3. Apply production technologies in fruit and plantation crops
4. Manage pests of fruit and plantation crops
5. Control diseases of fruits and plantation crops
6. Handle physiological disorders of fruit and plantation crops

Theory

Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, sapota, apple, pear, peach, walnut, almond and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

References

1. Ben Pike, 2011. The Fruit Tree Handbook, UIT Cambridge Ltd
2. Peter. K.V., 2011. Plantation crops, NBT publication
3. Kumar.N., 2017. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, CBS Publishers; 2nd edition
4. Ponnuswami.V., 2015. Text Book on Fruit & Plantation Crops – 2015, Narendra Publishing House
5. Tyagi. S.K., 2010. Handbook of Fruit Crops, Jain Brothers.

21HO1301 INTRODUCTORY MICROBIOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The discovery of microbial cells, their structure and metabolism
2. The different types of microscopes and staining techniques.
3. The beneficial use of microorganisms and their genetics

Course Outcomes:

On completion of this course, students will be able to

1. Acquire knowledge about the structure of microbes
2. Understand the genetics and metabolism in bacterial cells
3. Evaluate the different sterilization methods
4. Explore beneficial microbes for biotechnologies applications
5. Explain the types of interaction between different soil microflora.
6. Isolate different agricultural important microbes using different culture media

Theory

History and Scope of Microbiology: The discovery of microorganism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelia growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association. Sterilization methods – Physical and chemical, Isolation of pure cultures and preservation of cultures, Plant growth promoting microorganisms and mushrooms – Economical importance, industrially important microorganisms in large-scale production and common microbial fermentations. Mushrooms- edible and poisonous types, nutritive values, Culturing and production techniques.

Practical

Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plates, turbid metric estimation of microbial growth, mushroom culture, spawn production, Culture and production techniques, harvesting, packing and storage.

References

1. Madigan, M.T. and J. M Martinko, 2014. Brock Biology of Microorganisms 14th Edn. Pearson.
2. Heritage, J., E G V Evans, R A Killington, 2008. Introductory Microbiology. Cambridge University press P. date
3. Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. Biology of Microorganisms. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Singh, R.P. 2007. General Microbiology. Kalyani Publishers.
5. Pelczar, M. J. 1998. Microbiology 5th Edn. Tata Mc. Grow Hill Education Pvt. Ltd.

21HO1302 FUNDAMENTALS OF SOIL SCIENCE

Credit: 1:0:1(1+1)

Course Objectives:

To impart knowledge on

1. Soil forming process and physical properties of soil.
2. Soil chemical properties and reactions.
3. The impacts of soil pollution and the remediation measures.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genesis, pedological and edaphological concepts of soil
2. Remember different systems of soil classification
3. Evaluate the soil chemical properties and use them for soil reclamation.
4. Gain knowledge on physical properties of Soil
5. Apply the knowledge for choosing crops and Irrigation systems
6. Analyze the soil pollutant factors and recommending suitable remedial measures for soil improvement

Theory

Composition of earth's crust, soil as a natural body – major components. Eluviation and alleviations formation of various soils. Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption,

limitations, textural classes, use of textural triangle; absolute specific gravity/particle density, definition, apparent specific gravity/bulk density –factors influencing, field bulk density. Relation between BD (bulk density), AD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value hue and chroma. Munsell colour chart, factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal, soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Rock & Minerals classification, Pedogenic process. Objectives of soil science research institute in India (NBSS & LUP, ISSS, LTFE & NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Soil Biology benefits and harmful effects. Methods and objective of soil survey Remote sensing application in soil and plant Studies, Soil degradation. Elementary knowledge of soil taxonomy classification and soils of India. Soil organic matter: composition, properties and its influence on soil properties; humic substances. Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Quantification of minerals and their abundance. Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Estimation of soil moisture using gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of pore space of soil. Determination of field capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by field method. Determination of cation exchange capacity of Soil. Study of soil map. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

References

1. Brady Nyle Cand Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., NewDelhi.
2. Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, NewDelhi.
3. Sehgal , J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.
4. Dilip Kumar Das, 2015. *Introductory Soil Science*. Kalyani Publishers, Ludhiana.
5. Biswas, T.D. and Mukharjee, S.K., 2015. *TextBook of Soilscience*. Tata McGraw Hill Publishing Co. Ltd., NewDelhi.
6. Brady, N.C., 1995. *The Nature and properties of Soils*. Macmillan Publishing Co, New York.
7. Ghildyal, B.P. and Tripathi, R.P., 1987. *Soil Physics*. Acad. Press. New York.
8. Kolay, A.K., 1983. *Basic concepts of Soil Science*. Wiley Eastern Ltd., New Delhi
9. Brady, N.C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition), Pearson Education, NewDelhi.
10. Foth, H.D., 1991. *Fundamentals of Soil Science* (8th Edition), John Wiley & Sons, NewDelhi.
11. Das, D. K., 2011. *Introductory Soil Science* (3rd Edition), Kalyani publisher, Ludhiana (India).
12. Khan, T.O. 2013. *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland
13. Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
14. Gupta, P. K. 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
15. Jaiswal, P. C. 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
16. Jackson, M. L. 2012. *Soil Chemical Analysis: Advanced Course*, Scientific Publisher

21HO1351 FUNDAMENTALS OF PLANT PATHOLOGY

Credits: 2:0:1(2+1)

Course Objectives:

To impart knowledge on

1. Plant diseases and plant pathogens
2. Classification and life cycle of plant pathogens
3. Basics of plant disease management

Course Outcomes:

On completion of this course, students will be able to

1. Remember the factors responsible for disease development
2. Understand the importance of different plant pathogens with their characteristics and classification
3. Recall reproduction, survival and transmission of plant pathogens
4. Explain the mode of dispersal, role of enzymes and toxins in disease development
5. Analyze defense mechanism of plants and epidemiology factors
6. Apply knowledge on management measures.

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes. Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes. Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction. Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites. Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, Anguina, Radopholus etc.) Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants. Epidemiology: Factors affecting disease development. Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipment and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

Suggested Reading:

1. Agrios, G.N.2005. Plant Pathology(5thEd.). Elsevier Academic Press. Alexopoulos, C.J.,Mims, C.W. and Blackwell, M. 2014. Introductory Mycology (4thEd.). Wiley India Pvt td.Jayaraman,
2. J. and Verma, J. P. 2002.Fundamentals of Plant Bacteriology (Reprint, 2015). Kalyani publishers,
3. New Delhi
4. Ravichandra, N.G. 2013. Fundamentals of Plant Pathology. PHILearning Pvt Ltd.639p.
5. Walkey, D. G. 1991. Applied Plant Virology (2nd Ed.).Springer.
6. Webster,J.andWeber,R.W.S.2007.IntroductiontoFungi.(3rdEd.).CambridgeUniversitypress.
7. Thorne, G. 1971. Principles of Nematology, McGraw Hill Book Co., New York, London

21HO1501 ELEMENTARY PLANT BIOCHEMISTRY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of biochemistry in medicine, agriculture and pharmaceutical industries
2. Importance of biomolecules with structure classification and function
3. Synthesis and storage of metabolic energy

Course Outcomes:**On completion of this course, students will be able to**

1. Understand the importance of biomolecules in medicine, agriculture, pharmaceuticals and ethics
2. Identify, Classify and group the biomolecules and
3. Draw the structure and comprehend the properties of the biomolecules
4. Understand the basic mechanism of the various biosynthetic pathways
5. Conceptualize the integration of various metabolic processes and their importance
6. Explain the structures of carbohydrates, proteins, vitamins, nucleic acids and lipids in drug discovery

Theory

Carbohydrates: Occurrence, classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation. Lipids: Classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance. Plant pigments – structure and function of chlorophyll and carotenoids, sterols, basic structure, role of brassinosterols in plants. Proteins: Classification, function and solubility, amino acids –classification and structure, essential amino acids, properties of amino acids, colour reactions, amphoteric nature and isomerism; structure of proteins –primary, secondary tertiary and quaternary properties and reaction of proteins. Enzymes: Classification and mechanism of action; factors affecting enzyme action, co-factors and coenzymes. Vitamins and minerals as co-enzymes/ co-factors. Carbohydrate metabolism – glycolysis and TCA-cycle; metabolism of lipids, fatty acid oxidation, biosynthesis of fatty acids, electron transport chain, bioenergetics of glucose and fatty acids, structure and function of nucleic acid replication, transcription and translation.

Practical

Preparation of standard solutions and reagents; Carbohydrates: Qualitative reactions. Estimation of starch; Estimation of reducing and non-reducing sugars from fruits. Amino acids: Reactions of amino acids. Proteins: Estimation of proteins by Lowry's method; Fatty acids: Estimation of free fatty acids; Determination of iodine number of vegetable oils; Vitamins: Estimation of Ascorbic acid; Techniques: Paper chromatography, Thin layer chromatography; Electrophoresis of pigments extracted from flowers, Extraction of oil from oil seeds; Enzymes: Enzyme assay, Enzyme Immobilization.

Suggested Reading:

1. Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry*. Freeman Publishers
2. Voet, D and J. G. Voet. 2004. *Biochemistry* 4th Edn. Wiley & sons Publishers. USA.
3. Sadashivam, S and A Manickam,. 1996. *Biochemical methods for Agricultural sciences*. New age International publishers, New Delhi.
4. Voet, D. and J.G Voet. 2004. (3rd edit). *Biochemistry*. John Wiley & sons Incl.USA.
5. Rameshwar, A. 2006. (3rd edit). *Practical Biochemistry*. Kalyani Publishers, NewDelhi.
6. Buchanan, B. B., W. Gruissem, and R. L. Jones, 2002. *Biochemistry and molecular biology of plants*. 2nd edition. Blackwell publications, UK.

21HO1502 INTRODUCTORY CROP PHYSIOLOGY**Credit: 1:0:1 (1+1)****Course Objectives:****To impart knowledge on**

1. Concept of water relations in plants
2. Physiological processes of plant and its effects on plant growth
3. Role of plant growth regulator and its application in crop growth

Course Outcomes:**On completion of this course, students will be able to**

1. Understand the physiology of plant tissues and cells
2. Remember water movement in plant systems like diffusion and osmosis
3. Apply the concept of water relations, mineral uptake in the field of agriculture
4. Summarize the various physiological processes
5. Measure and analyse the physiological parameters of crops
6. Practice the use of growth regulators correctly to solve physiological problems

Theory

Water relations in plants: role of water in plant metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant nutrition:

essentiality, mechanism of absorption and its role in plant metabolism. Biological nitrogen fixation photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO₂ fixation – C₃, C₄ and C₄ metabolism, advantages of C₄ pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, secondary metabolites and plant defense.

Practical

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

References

1. Salisbulry. 2007. *Plant Physiology*. CBS. New Delhi.
2. Taiz, L. 2010. *Plant Physiology*. SINAUR. USA.
3. Zeiger. 2003. *Plant Physiology*. PANIMA. New Delhi.
4. Edward E. Durna. 2014. *Principles of Horticultural Physiology*. CABI, UK.
5. Delvin, R.M. 1986. *Plant Physiology*. CBS. Delhi.
6. Richard, N. Arteca. 2004. *Plant Growth Substances*. CBS. New Delhi.
7. Jacobs, W. P. 1979. *Plant Hormones and Plant Development*. Cambridge Univ. London.
8. Basra, A. S. 2004. *Plant Growth Regulators in Agriculture & Horticulture*. HAWARTH press. New York.
9. Lincoln Taiz and Eduards Zeiger (5th Edition). *Plant physiology*
10. Noggle G.R and Fritz T.G. *Introductory Plant Physiology*
11. Pandey and Sinha. *Plant Physiology*
12. Salisbury and Ross. *Plant Physiology*
13. Carl fedtke. *Biochemistry and Physiology of Herbicide Action*
14. Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. *Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation* Horst Marschner, *Mineral Nutrition of Higher plants*

21HO1503 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The growth and developmental functions of horticultural crops
2. Plant bio-regulators and their functions
3. Physiology of fruit growth and development

Course outcomes:

On completion of this course, students will be able to

1. Explain the functions related to growth and development of horticultural crops
2. Discuss the application of Plant bio-regulators for specific functions of the plant
3. Describe the process of fruit setting and related physiology
4. Prepare hormonal solutions that influence various functions of the crop
5. Identify the physiological disorders and suggest remedial measures
6. Describe the physiology of fruits under post-harvest storage

Theory

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and

fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

References

1. Zeiger. 2003. Plant Physiology. Panima. New Delhi.
2. Delvin, R.M. 1986. Plant Physiology. CBS. Delhi.
3. Edward E. Durna. 2014. Principles of Horticultural Physiology. CABI, UK.

21HO2002 INTRODUCTION TO MAJOR FIELD CROPS

Credits 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. The classification and distribution of field crops
2. The concepts of various cropping systems and its application
3. The different cultural practices for the cultivation of major field crops

Course outcomes:

At the end of this course, students will be able to

1. Understand the classification and distribution of major field crops
2. Identify the field crops, fodder crops and green manure crops
3. Understand the concepts of various cropping systems followed in crop production
4. Apply the cultivation practices of major field crops
5. Adopt the nutrient and weed management practices for effective use
6. Describe the cultural practices of fodder and green manure crops

Theory

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals (rice), pulses (red gram), oil seeds (groundnut), sugar crops (sugarcane) and fodder crops, green manuring, crop rotation.

Practical

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

References:

1. Gurarajan. B., R.Balasubramanian and V.Swaminathan. 2008. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
2. Rajendra Prasad 2002. Text Book of Field crops Production, ICAR, New Delhi.
3. Reddy. S.R. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
4. Singh. S.S. 2005. Crop Management. Kalyani Publishers, New Delhi. UAS, Bangalore. 2011.
5. Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi. 2018.
6. Peter K.V. 2018. Zero hunger in India: Policies and Perspectives. Brillion Publishing.

21HO2003 INTRODUCTORY AGRO FORESTRY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The importance of forest and agroforestry systems in sustaining the land productivity
2. Crop tree interactions in different types of agroforestry systems
3. Productive and protective functions of agroforestry

Course Outcomes:

On completion of this course, students will be able to

1. Understand the forest eco system and forest regeneration.
2. Remember the concepts of agroforestry practiced in various agroecosystems
3. Apply the knowledge for developing agro forestry, wind breaks, shelter belts, silviculture and social forestry.
4. Recall the multipurpose trees in agroforestry systems
5. Analyse the impact of nitrogen fixation, carbon sequestration and develop strategies for climate mitigation.
6. Explain the beneficial effects of agro forestry in relation to nitrogen fixation, soil conservation, litter dynamics and nutrient cycles

Theory

Introduction – definitions of basic terms related to forestry, importance and objectives of silviculture, types of forests-salient features of Indian Forest Policies. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations- tree stand management. Agroforestry – definition and concepts Agroforestry systems and practices- different agroforestry systems prevalent in the country and Tamil Nadu, shifting cultivation, taungya, alley cropping, windbreaks and shelter belts, plantation crop combinations, home gardens. Multi purpose trees in agroforestry, characteristics- Understorey components and diversification potentials- Component interactions- above ground and below ground interactions. Productive and protective functions- Nitrogen fixation- Soil conservation- Litter dynamics and nutrient cycling – Carbon sequestration and climate change mitigation - Social forestry- concept and importance, practices in different agro ecosystems

Practical

Identification of tree-species. Diameter measurements using calipers and tape. Height measurement of standing trees by shadow method, single pole method and hypsometer. Nursery lay out, seed sowing, vegetative propagation techniques. Different agroforestry systems like sAgroforestry systems, Silvopastoral systems, Agroforestry systems and their interactions

References

1. Puri, S and Panwar, P. (ed.). 2007. Agroforestry Systems and Practices. New India Publishing Agency, New Delhi, 643p
2. Gupta, R.K. 1993. Multipurpose Trees for Agroforestry and Wasteland Utilization. Oxford and IBH, 562p
3. Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publications, Dordrecht, The Netherlands, 499p

21HO2004 WEED MANAGEMENT IN HORTICULTURAL CROPS

Credit: 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. Identification of weeds, characters of weeds, and classification of weeds
2. Methods of weed control and Integrated weed management in different crops/ cropping systems
3. Herbicide classification, formulation, application, selectivity and compatibility of herbicides

Course outcomes:

On completion of this course, students will be able to

1. Identify different types of weeds and their ecosystem
2. Understand the weeds survival mechanisms
3. Recommend herbicides understanding their effects on the crops
4. Adopt different weed control methods
5. Apply integrated weed management practices
6. Analyse the economics of weed control in horticultural crops

Theory

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses. Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

References

1. Crafts, A.S. and W.W. Robbins. 1973. Weed Control. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Gupta, O.P. 1984. Scientific Weed Management. Today and Tomorrow Printers and Publishers, New Delhi.
3. Gupta, O.P. 2015. Modern Weed Management. Agro Bios (India), Jodhpur.

4. Naidu, V.S.G.R., Handbook of Weed Identification. Directorate of Weed Research, Jabalpur.
5. Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. Weed management of Horticultural Crops. Agrobios (India), Jodhpur.
6. Ramamoorthy, K. and Subbian, P., Predominant Weed flora in hill –ecosystems. Agrobios (India), Jodhpur.
7. Rao, V.S. 2000. Principles of Weed Science. Oxford & IBH Publishing Co., New Delhi.
8. Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. All About Weed Control. Kalyani Publishers, Ludhiana.
9. Tadulingam, C. and Venkatnarayana, D. 1955. A Handbook of Some South Indian Weeds. Government Press, Madras.
10. Thakur, C. 1977. Weed Science. Metropolitan Book Co. Pvt. Ltd., New Delhi.

21HO2005 ORGANIC FARMING

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Historical, physio-chemical, biological and ecological basis of organic farming including various crop and soil management practices
2. Agronomic practices and farming techniques of different crops and cropping systems under organic farming
3. The concepts related to legislation, inspection, certification, and marketing of organic produce

Course Outcomes:

On completion of this course, students will be able to

1. Remember the concepts of organic farming
2. Understand the requirements for organic production of crops
3. Elaborate the organic composting methods
4. Apply Integrated strategies by using non-chemical methods for management of pests, diseases and weeds
5. Understand the certification, labelling and accreditation processes involved in organic cultivation
6. Analyse different marketing strategies of organic farm produce

Theory

Introduction, concepts, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, bio-fertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labelling and accreditation processors, marketing, exports.

Practical

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post-harvest management.

References

1. Dahama, A.K. 2007. Organic farming for sustainable agriculture. Agrobios (India), Jodhpur.
2. Arun. K. Sharma. 2011. Handbook of Organic farming. Agrobios (India), Jodhpur.
3. Palaniappan, S.P. and K.Annadurai. 2010. Organic farming – Theory and Practice. Scientific Publishers. Jodhpur.
4. Thapa, U and P. Tripathy. 2006. Organic farming in India- Problems and Prospects. Agrotech publishing agency, Udaipur.
5. Veeresh, G.K. 2006. Organic farming. Foundation Books. New Delhi.
6. Purshit, S.S. 2006. Trends in Organic Farming in India. Agros Bios (INDIA), Jodhpur.
7. Thampan, P. K. 1995. Organic Agriculture. Peckay tree Crops Development Foundation, Cochin, Kerala.
8. Sathe, T.V. 2004. Vermiculture and Organic Farming. Days Publishing House, New Delhi.

21HO2052 HORTI-BUSINESS MANAGEMENT

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. Farm and business management principles
2. Applying economic principles to organization and management of businesses with emphasis on choice of optimal enterprise combinations
3. Functional areas of management

Course Outcomes:

On completion of this course, students will be able to

1. Recall farm and business management concepts
2. Analyze the time value of money
3. Apply economic principles applicable in farm management
4. Understand the functional areas of management
5. Gain knowledge on planning, marketing programs
6. Prepare financial statements, budgeting and project management

Theory

Farm management - definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concepts, curves and functions – factors, product, relationship – factors relationship, product relationship, optimum conditions, principles of opportunity cost-equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation evaluation measures.

References

1. Heady Earl O and Herald R. Jenson, 1954, Farm Management Economics. Prentice Hall, New Delhi
2. S.S. Johl, J.R. Kapur ,2006, Fundamentals of Farm Business Management.Kalyani Publishers, New Delhi
3. Karan Singh and Kahlon A S. Economics of Farm Management in India. Theory and Practice. New Delhi.
4. Allied L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
5. Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
6. P.C. Thomas. Managerial Economics, 9th Ed. Kalyani Publishers.
7. K.K. Dewett and M.H. Navalur. Modern Economic Theory. S. Chand & Sons, New Delhi.
8. P. Subba Rao. Human Resource Management. Himalaya Publications.
9. S.P. Jain. Financial Accounting. Kalyani Publications, Ludhiana.
10. Shapiro E. Macro economic analysis. Galgotia Publications Delhi
11. Barry P J, Hopkins J A and Baker C B. Financial Management in Agriculture, 6th ed.Danville, IL Interstate Publishers.
12. Gittiner, J P., 1982. Economic analysis of agricultural projects. The John Hopkins University Press Baltimore, USA,
13. Benjamin Mc Donald P 1985. Investment Projects in Agriculture- Principles and Case studies. Longman Group Limited. Essex. UK y Pandey
14. U K 1990. An Introduction to Agricultural Finance .Kalyani Publishers New Delhi.

21HO2101 EDUCATIONAL TOUR – I

Credits 0:0:1 (0+1)

Course Objectives:

To impart knowledge on

1. Functioning of agricultural research institutions throughout the state
2. On-going agricultural research and extension programs
3. Region specific crop production technologies

Course Outcomes:

On completion of this course, students will be able to

1. Categorize agricultural crops grown in the different agro climatic zones of Tamil Nadu.
2. Remember different agro-climatic zones of Tamil Nadu
3. Distinguish social, cultural and economic differences in various agricultural zones.
4. Compare and contrast the different soil types and cropping systems in Tamil Nadu.

5. Recommend climate and region-specific cultivation practices.
6. Analyze different rainfall patterns of different agro-climatic zones of Tamil Nadu

Practical

The study tour Program is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution. In the study tour Program, full attendance is mandatory for a pass as per the ICAR regulations. The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

21HO2102 FUNDAMENTALS OF EXTENSION EDUCATION

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The concept of extension education and its importance in agriculture development
2. Various rural development programs aimed at poverty alleviation and to increase employment opportunities and their analysis
3. The new innovations being brought into the agricultural extension in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand agricultural extension and rural development programs
2. Create employment opportunity based on the knowledge gained on different schemes operated by state and central governments.
3. Remember the new innovations in the area of agricultural extension in India
4. Apply the practical knowledge gained on technology transfer from lab to land.
5. Create awareness among farmers on different communication technology and journals available for scientific farming
6. Apply the Knowledge for uplifting poor and marginal farmers

Theory

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Horticulture extension: process, principles and selected Programs of leading national and international horticultural institutes. People's participation in Horticulture programs. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work. Rural development: meaning, definition, objectives and genesis. Transfer of technology Programs like lab to land Program (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Program (TARP) etc. of ICAR. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Adoption and diffusion process, Teaching and learning-concepts and principles, teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. ICT in Extension education, ICT use in rural India.

Practical

Visits to study structure, functions, linkages and extension programs of ICAR institutes/ voluntary organizations/Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPV like poster, chart, flash cards, folders etc. and Audio-Visual Aids like OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of horticultural extension programs. Preparation of Village horticultural productions plan.

Suggested Reading:

1. Adivi Reddy, A., 2001, Extension Education, Sree Lakshmi press, Bapatla.
2. Dahama, O. P. and Bhatnagar, O.P., 1998, Education and Communication for Development, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
3. Jaliha, K. A. and Veerabhadraiah, V., 2007, Fundamentals of Extension Education and Management in Extension, Concept publishing company, New Delhi.

4. Muthaiah Manoraharan, P. and Arunachalam, R., 2003. Agricultural Extension, Himalaya Publishing House (Mumbai).
5. Sagar Mondal and Ray, G. L., 2012. Text Book on Rural Development, Entrepreneurship and Communication Skills, Kalyani Publications, Bangalore.
6. Rathore, O. S. et al., 2012, Handbook of Extension Education, Agrotech Publishing Academy, Udaipur.
7. Ray, G. L., 1991 (1st Edition), Extension Communication and Management, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
8. Supe, S. V., 2013 (2nd Edition), A Text Book of Extension Education, Agrotech Publishing Academy, Udaipur.
9. Van Den Ban, A. W. and Hawkins, H. S., 2002. Agricultural Extension, S. K. Jain for CBS Publishers & Distributors, New Delhi.

21HO2103 EDUCATION TOUR – II

Credits 0:0:1 (0+1)

Course Objectives:

To impart knowledge on

1. The various crops and cropping systems of South India.
2. The various agricultural and agro-based institutions/ Research Stations/ Colleges in South India
3. The ongoing agricultural research and extension programs implemented by the Government and the State Agricultural Universities

Course Outcomes:

On completion of this course, students will be able to

1. Identify the various crops across the states of South India
2. Discuss the cropping systems practiced in the different agro-climatic zones of South India
3. Describe the soils, irrigation practices, sources of irrigation and other farming related activities in different parts of their visit
4. Assess the scope of farming, agro-based industries and related activities across the states of South India.
5. Relate the social and cultural aspects of the people of different agricultural zones
6. Discuss the commercial operations of farming and related activities

Practical

The study tour Program is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour Program, full attendance is mandatory for a pass as per the ICAR regulations. The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

21HO2104 RURAL HORTICULTURAL WORK EXPERIENCE (RHWE)

Credits 0:0:20 (0+20)

Introduction

The Honorable Prime Minister of India launched Student READY“ Program on 25th July 2015. The term “READY” refers to “Rural Entrepreneurship Awareness Development Yojana”. To reorient graduates of agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the Program as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

There are two components:

STUDENT READY – Placement in Industries 0:0:10 (0+10)

STUDENT READY – Placement in Villages 0:0:10 (0+10)

The Rural Horticultural Work Experience (RHWE) helps the students primarily to understand the rural situations, status of agricultural technologies adopted by farmers, prioritize the farmers’ problems and to develop skills & attitude of working with farm families for overall development in rural area.

The students will undertake this program during the seventh/eighth semester for a maximum duration of 20 weeks with a weightage of 0+20 credit hours in two parts namely RHWE and IP. RHWE will consist of general orientation and on campus training by different faculty followed by village attachment/unit attachment in

University/ College/ KVK or a research station. Under IP, the students would be attached with the agro-industries to get an experience of the industrial environment and working. Due weightage in terms of credit hours will be given depending upon the duration of stay of students in villages/agro industries. At the end of RHWE & IP, the students will be given two week for project report preparation, presentation and evaluation. The students would be required to record their observations in field and agro-industries on daily basis and will prepare their project report based on these observations.

Course Objectives:

To impart knowledge on

1. Socio-economic conditions of the farmers and their problems
2. Extension teaching methods in transfer of technology to enhance the communication skills of students
3. Functioning of horti-based industries

Course Outcomes:

On completion of this course, students will be able to

1. Understand the horti-based farming systems
2. Acquaint themselves with farmers' problems and situations
3. Acquire knowledge on horticultural innovations through demonstrations and farmers training/ field day arranged with help of Horticultural extension officers
4. Know the government, private and NGOs involved in the rural development activities of the villages
5. Survey the villages for undertaking socio-economic studies
6. Understand the Horti based industrial operations

Course Content

Unit I: Rural Horticultural Work Experience (RHWE)

The unit enables students to study of Village and Farm households (Agro-Ecological and Socio- Cultural Economic, Setting), particularly:

- Village settlement pattern, demography, climate, land utilization pattern, resources inventory, infrastructure facilities, rural institutions, organizations, groups, customs, beliefs and value systems.
- Study of cropping pattern, cropping systems, extent of adoption of latest technologies and constraints – cereals, millets, pulses, oilseeds and horticultural crops–productivity – Decline in productivity – Yield gap – constraints in production. Specific study on the following:
 - i. Agronomic Intervention.
 - ii. Plant protection Intervention.
 - iii. Soil Improvement Intervention.
 - iv. Fruit and Vegetable Production Intervention.
 - v. Food Processing and Storage Intervention.
 - vi. Animal Production Intervention.
- Understanding social participation, leadership pattern, scientific orientation and role of women and youth in agricultural development.
- Extension methods and Audio-visual Aids – Practicing individual, group and mass contact methods.
- Studying the existing Indigenous Technical Knowledge and its importance for technology generation.
- Understanding the communication pattern in villages.
- Studying farm women associations / farmers associations / commodity groups and learning their functioning and use of their services for dissemination.
- Conducting need-based skill demonstrations in the villages.
- Developing Whole Village Development Plan.
- Contacting individual farmers to assess the farming systems practiced by marginal, small, medium, big farmers and farm Women.
- Preparation of Individual farm plan.
- Documentation of success stories of the farmers.
- Study of University/College/KVK Research and Extension activities and Agricultural development schemes in the villages.

Unit II: Study under Industry Placement

- Industries to be studied include seed/sapling production, pesticides- insecticides, post –harvests – processing –value addition, Agri-finance institutions, dairy, poultry, etc.
- General information about the Agro-Industry – Nature of business – Brief history of the firm - Licensing and other legal aspects of the firm.
- Study of structure, functioning, objective and mandates of the industry.
- Study of various processing units and hands-on trainings under supervision of industry staff.

- Employment generated by the industry.
- Contribution of the industry-promoting environment.
- Learning business network including outlets of the industry.
- Skill development in all crucial task of the industry.
- Documentation of the activities and task performed by the students.
- Performance evaluation, appraisal and ranking of students.

RHWE Components and Activities:

Component	Activity	No. of weeks*	Credit Hours
Preparation	General orientation & On-campus training by different faculty members	2	
RHWE	Village Placement (including exposure to Extension Centre, University, KVK, Research station & NGO)	8	10
	(Agro) Industry Placement	8	10
Evaluation	Project Report Preparation, Presentation and Viva-Voce	2	
*as per the ICAR V Dean committee Recommendation (P:638)			

Evaluation of student RHWE program

- i. Students shall be evaluated component-wise under village attachment/ agro- industrial attachment.
- ii. The university will designate a RHWE Program Coordinator who along with Mentor-teachers for the students' groups would be become the committee of evaluators. While marking the performance, due weightage to the observations made by the Farmers/ Horticultural Extension Worker / Scientists/Agro-industrial Officer and the Program Coordinator with whom they are attached will be given. The students' will be evaluated for 100 marks. The outline of evaluation and distribution of marks will be as follows:

Component	Village Attachment	Horti. Extension Centre Attachment	KVK/Research / NGO Attachment	Agro-Industry	Total Mark
Participation, Oral Presentation and Work Diary maintained	30	5	5	15	55
Preparation Report	10	5	5	10	30
Overall Exhibition**					15
Total	40	10	10	25	100

**Final Display and Exhibition of the learning outputs/findings/visuals/charts/posters/ Models before the evaluation committee

Note :Only one examination (End semester) will be conducted at end of the semester for 100 marks

Performance during placement:

The committee led by the RHWE Coordinator and Mentor-teachers, who frequently visits /villages in rotation will assess the students' performance during the placements in villages. In case of placements in industries/institutions, the committee in consultation with the concerned designated person in the host institute will assign the marks for the performance of students.

Group Presentation and Viva-voce:

After completion of student's placements in rural areas and institutions/industries, the Committee will have group discussion session to assess each student's level of participation and interaction abilities based on experience gained in RHWE. Each student along with the student's group to which he belongs will give a brief presentation on the work that has been carried out, experience gained and points for future consideration. A Viva- voce examination will be conducted for each student on the relevant topics to know the overall impact of RHWE on the student, on the farming community and on the Institutions. Using the outputs and findings from various activities carried out in the filed Programs, the student groups shall put up a small exhibition/display to be seen, observed and scrutinized by the evaluation committee.

Attendance & diligence:

Marks are given for student's presence and attentiveness in classes conducted on the campus and placements in rural areas/institutions.

Work diary:

Evaluation of work diary indicating brief description of activities carried out by the student every day during the placements.

Practical record/Project report:

- For each component, the student will maintain a practical record. The record will have detailed description for all the topics specified. The description will be on statement of tasks carried out, sequential steps/procedure followed in completion of the task, approaches used to accomplish the task, impact of the task on the intended audience, feedback obtained, and lessons learnt. For the courses where placements in other institutions/industries are made, the student will write report with description on background of the institution as per topics given in the syllabus.
- Since the credit hours allotted to the RHWE program are grade-based, the minimum condition of attendance and grading system will apply for the program as will be applicable to other courses.
- It is expected that at the end of RHWE program, the students should gain familiarity and competency for working with rural stakeholders viz, Farmers, Development Departments, Agro-industries, NGOs and others. The evaluation committee must ensure percentage increase in this competency at the end & successful organization of all RHWE programs.

Monitoring & Coordination

- For each batch, there will be a designated RHWE coordinator and concerned Mentor-teachers of the batch/student groups who will make periodical visits the rural- placement areas to guide, supervise and monitor the work of students as well as to evaluate the performance of the students on the concerned subject. They will also stay overnight once in a fortnight to support the students during the extension educational activities conducted during evening hours.
- The RHWE coordinator in liaison with KVK/ZRS/NGO and other developmental departments will facilitate visit of Mentor-teachers to villages after the return of the students to ensure continued technical support to farmers, till the 'end of crop season. The Dean/ HoD of the college will provide necessary resources-material, finance, man power, vehicles, etc. and ensure participation of the designated Mentor-teachers in the RHWE activities. **Coordination Committee for RHWE may consist of:**
 1. Dean of the Faculty - Chairman
 2. HOD, Agriculture - Convener
 3. Senior Teacher of Extension Education - RHWE Coordinator
 4. Student Counselor/Mentor - Member
 5. Representative of State Dept. of Agriculture (AO) - Member
 6. Village Leader / Farmer (off-campus representation - Member
 7. Agro-industry Representative -Member
 8. Group Facilitator (Student representatives - Member

Other General Guidelines:

- A mid-term appraisal will be taken up by the Heads of Departments and the Evaluation Committee for reviewing the work carried out by the students.
- Periodical visits will have to be made by Evaluation Committee members to the locations to monitor, guide and supervise the students.
- An exhibition will be conducted highlighting the experiential learning process, depicting the outcomes, supported with charts, posters, specimens, models, etc., on completion of the Program.
- Mass media coverage may be given for the different activities undertaken by the students. Local prominent persons may be invited for RHWE Programs in villages.
- Appropriate documentation has to be ensured at all stages. Photographs/video coverage and newspaper messages should be ensured and arranged in possible locations/events.

Instructions to students

- No student should leave the location during this period on any account even during holidays.
- A movement register will have to be maintained indicating the date, time, places, purposes of visit and expected time of arrival.
- Students while leaving for respective villages/Agriculture Dept office/Industry should leave a message about their Program in the movement register maintained for this purpose where they are staying.
- They should maintain an observation note for recording on the spot details during their visits to record daily activities and Programs.
- All the students will be given a Practical Manual for which the details should be collected during the course of the Program.

- On reaching the location of their stay, all students should intimate the Head of the Department / RHWE Coordinator and Mentor-Teacher about their arrival.
- The RHWE Coordinator and Mentor-Teachers will guide the students about the villages identified for each student and details of the place of stay.
- The Group Facilitators will guide the students in the selection of NGO, ADA office, and Agro-Industry for each group in and around the location.
- All students should report to the Professor and Head, Department of Agriculture, RHWE-Coordinator and Mentor-Teachers and the Group Facilitators about the particulars regarding the villages allotted to them, the names and addresses of the contact farmer in the villages and work carried out every week.
- Students should avoid unnecessary exchange of ideas with the local people on politics, religion, caste, etc., which will spoil the harmony of Program.
- Students should contact maximum number of farmers in the locality and participate in the farm operations and record the observations about marginal, small and big farmers and one farm woman.
- Students should avoid doing anything, which may damage the image of students, as well as students' institution.
- Head of the Department of Agriculture, RHWE Coordinator and Mentor -Teachers will make surprise inspection to know the students activities.
- In case of emergency, students may contact Professor and Head, Department of Agricultural/ RHWE Coordinator/ Mentor-Teachers.
- The mobile numbers of Group facilitators may be obtained by students.
- The students should keep in readiness their observation note and Practical Manual for evaluation on the final day of RHWE.

Suggested Reading:

1. ICAR Fifth Deans Committee Report, Agricultural Education Division, Indian Council of Agricultural Research (ICAR), New Delhi.
2. Academic Information Hand Book, 2019, KITS, Coimbatore.
3. RHWE manual, guidelines of TNAU, Coimbatore.
4. Personal discussion with TNAU experts and brain storming contribution from Agri. Faculty of KITS.

21HO2152 NEMATODE PESTS OF HORTICULTURAL CROPS AND THEIR MANAGEMENT

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The taxonomical classification and characterization of parasitic nematodes
2. Symptomology and control measures of nematode
3. Best nematode control practices using INM

Course Outcomes:

On completion of this course, students will be able to

1. Have a clear knowledge about the various morphological and taxonomical classifications of nematode
2. Identify the nematode symptoms in plants and suggest control measures.
3. Identify the type of nematodes based on morphology and symptoms
4. Understand the nematode disease complexes in plants
5. Apply the INM practices in the field
6. Analyze and develop advanced Nematode control measures

Theory

History and development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, subtropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex. Integrated nematode management.

Practical

Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Suggested Reading:

1. Aurelio C. and Mukerji, K.G. 2009. Integrated Management of Fruit Crops Nematodes. Springer Publications.
2. Jonathan E.I, Cannayane, I., Devrajan, K., Kumar, S., Ramakrishan, S., Agricultural Nematology. TNAU, Coimbatore.
3. Vasanth Raju David, B. 2001. Elements of economic entomology. Popular book Depot, Chennai.

21HO2153 INSECT PESTS OF VEGETABLE, ORNAMENTAL AND SPICE CROPS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The insect ecology and factors responsible for outbreaks of pests and the methods of pest control in vegetable, ornamental and spice crops
2. The integrated pest management of vegetable, ornamental and spice crops
3. The ecology, importance and management practices of storage pests in vegetable, ornamental and spice crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the ecology and economic importance of pests of vegetable, ornamental and spice crops
2. Acquire the knowledge on the factors responsible for outbreaks of pests
3. Identify the injury symptoms and pests of vegetable, ornamental and spice crops
4. Develop an integrated pest management practices for framing the crop protection strategies
5. Understand the ecology and economic importance of storage pests of vegetable, ornamental and spice crops
6. Analyze the pesticide residual limits of chemicals used for pest management

Theory

Economic importance of insects in vegetable, ornamental and spice crops-ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host range, bioecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical

Study of symptoms, damage, collection, identification, preservation, assessment of damage/ population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

Suggested Reading:

1. Emmanuel, Sujatha, N, A., Kiran Patro, T.S.K. K, Reddy, M.L.N., Srinivasulu, B. and TSSK Sammuel Patro. 2015. Text Book on Integrated Pest Management of Horticultural Crops Astral International Publishers, New Delhi.
2. Dhalinal G.S. and Ramesh Arora Integrated Pest Management Concept and Approaches. Kalyani Publishers, Ludhiana
3. Reddy, P. P., 2010. Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur
4. Ranjit, P., 2012. Entomological Techniques in Horticultural Crops, New India Publishing Agency.
5. Srivastava.A. 2016. Text Book on Applied Entomology Vol. I & II. Kalyani Publishers, Ludhiyana

21HO2154 INSECT PESTS OF FRUIT, PLANTATION, MEDICINAL & AROMATIC CROPS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The insect ecology and factors responsible for outbreaks of pests and the methods of pest control in Fruit, Plantation, Medicinal & Aromatic crops
2. The integrated pest management of Fruit, Plantation, Medicinal & Aromatic crops
3. The ecology, importance and management practices of storage pests in Fruit, Plantation, Medicinal & Aromatic crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the ecology and economic importance of pests of fruit, plantation, medicinal & aromatic crops
2. Acquire the knowledge on the factors responsible for outbreaks of pests
3. Identify the injury symptoms and pests of fruit, plantation, medicinal & aromatic crops
4. Develop an integrated pest management practices for framing the crop protection strategies
5. Understand the ecology and economic importance of storage pests of fruit, plantation, medicinal & aromatic crops
6. Analyze the pesticide residual limits of chemicals used for pest management

Theory

General – economic classification of insects; Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, belladonna, pyrethrum, costus, croton, datura, *Dioscorea*, mint, opium, *Solanum khasianum* and. Storage insects–distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs).

Practical

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.

Suggested Reading:

1. David, B.V. 2006. Elements of Economic Entomology. Popular Book Depot, Chennai.
2. Butani, D.K. 2009. Insects and Fruits. Periodical Expert Book Agency, New Delhi.
3. Kiran Patro, Reddy, MLN., Srinivasulu, B., TSSK Sammuelpatro. 2015. Text Book on Integrated Pest Management of Horticultural Crops Astral International Publishers, New Delhi.
4. Dhalinal G.S. and Ramesh Arora Integrated Pest Management Concept and Approaches. Kalyani Publishers, Ludhiana
5. Reddy, P. P., 2010. Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur
6. Ranjit, P., 2012. Entomological Techniques in Horticultural Crops, New India Publishing Agency.
7. Srivastava.A. 2016. Text Book on Applied Entomology Vol. I&II., Kalyani Publishers, Ludhiyana

21HO2155 APICULTURE, SERICULTURE AND LAC CULTURE

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Importance of different beneficial insects such as honey bee, silkworm and lac insect
2. Detailed classification, life cycle and behaviour of honey bee, silkworm and lac insect
3. Technology and economics of honey, silk, lac production

Course Outcomes:

On completion of this course, students will be able to

1. Remember the species, life cycle of the beneficial insects
2. Identify the different species of honey bee and silkworm
3. Have Hands on training on the colonial behavior of honey bee and the production of honey
4. Grow and maintain the silkworms, and analyze the practical problems
5. Elaborate the knowledge on lac culture production and its problems
6. Understand the basics and economics needed to start and maintain a apiary or silkworm or lac unit

Theory

Introduction to beneficial insects. Importance and History of apiculture. Species of honeybees, Rock bee, little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons, Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues. Importance, History and development in India, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs. Silkworm rearing young age /chawki rearing and old age rearing of silkworms. Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture- Mulberry varieties, package of practices, Pests, diseases, and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

Practical

Honey bee colony, different beehives and apiculture equipment. Summer and winter management of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their

management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipments for silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

Suggested Reading:

1. David B.R and V.V.Ramamurthy. 2007 Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai
2. Mishra R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
3. Narasaiah M.L. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.
4. Singh, D and Singh, D.P. 2006. A handbook of Beekeeping, Agrobios (India).
5. Sunita, N.D., Guled, M.B., Mulla, S. R. and Jagginavar. 2003. Beekeeping, UAS Dharwad
6. Srivastava, K. P .A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

21HO2203 BREEDING OF FRUITS AND PLANTATION CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Objectives, concepts, propagation methods and breeding strategies of fruit and plantation crops
2. Advanced hybridization techniques in breeding of fruit and plantation crops
3. Breeding procedures and achievements in crop improvement of fruit and plantation crops

Course Outcomes:

On completion of this course, students will be able to

1. Outline the objectives, concepts, propagation methods of fruit and plantation crops
2. Understand plant genetic resources conservation and utilization in crop improvement
3. Develop breeding strategies for fruit and plantation crops
4. Acquire the knowledge in advanced hybridization techniques inbreeding
5. Apply methods of breeding in development of fruit and plantation crops
6. Enumerate achievements in crop improvement and the policies involved

Theory

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits. Pre breeding and breeding strategies, clonal selection, bud mutations, mutagenesis. Introduction to rootstock breeding, Introduction to Scion breeding, Gene silencing techniques: RNA interference (RNAi) technique, Virus Induced Gene Silencing (VIGS) technique, MicroRNA mediated Virus Induced Gene Silencing (MIR-VIGS), MicroRNA Induced Gene Silencing (MIGS), CRISPR-CAS systems and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistachonut, Apple, Pear, Plum, Peach, Apricot and Strawberry.

References

1. Anil Kumar Shukla 2004. Fruit breeding approaches & Achievements. International Book Distributing Co.
2. Kumar N. 2015. Breeding of Horticultural Crops: Principles and Practices 2nd Revised & Expanded Ed. New India Publishing Agency.
3. Darbeshwar Roy. 2016. Breeding of Fruit Crops. Narosa Publishing House, New Delhi.
4. Ramachandra R.K., Maheshwar D.L., Shoba N. 2016. Breeding Of Spice & Plantation. Jaya Publishing House.
5. Gyana Root, Peter K.V. 2018. Genetic Engineering of Horticultural Crops. Academic Press. Elsevier.US.

21HO2204 BREEDING OF VEGETABLE, TUBER AND SPICE CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The floral morphology, anthesis and pollination in different types of vegetables and Spices
2. The propagation methods and breeding strategies of Vegetables, tuber and Spice crops

3. Exploiting heterosis for quantitatively and qualitatively inherited traits

Course outcomes:

On completion of this course, students will be able to

1. Understand the conservation and utilization of plant genetic resources in vegetable, tuber and spices improvement
2. Distinguish the breeding strategies based on modifications in floral structures and pollination mechanisms
3. Understand the achievements in improvement of vegetables, tuber and spice crops
4. Analyze different propagation methods of tuber and spice crops
5. Adopt advanced breeding methods and produce high heterotic hybrids
6. Develop new varieties and hybrids of vegetables, tuber and spice crops

Theory

Breeding objectives and important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops tomato, brinjal, bhendi, capsicum, chilli, cucurbits, cabbage, cauliflower, tuber crops, potato, carrot, radish, spice crops (ginger, turmeric). breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adoptability and stability.

Practical

Floral biology and pollination mechanism in self and cross-pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

References

1. Akhilesh Sharma, Vivekan Katoch, Susheel Sharma and Chanchal Rana. 2016. Practical on Vegetable breeding. Kalyani Publishers, New Delhi.
2. Dhaliwal, M.S. 2009. Vegetable Seed Production & Hybrid Technology. Kalyani Publishers, Ludhiana.
3. Dhaliwal, M.S. 2012. Techniques of Developing Hybrids in Vegetable Crops. Agrobios. Jodhpur.
4. Hari Hara Ram, 2013. Vegetable Breeding: Principle and Practices. Kalyani Publishers, Ludhiana.
5. Kallo, G., 1998. Vegetable Breeding (Vol. I to IV). CRC Press. Florida. 1988.
6. Singh, H.P. 2009. Vegetable Varieties of India. Studium Press (India) Pvt Ltd. New Delhi.
7. Singh, P.K. 2005. Hybrid Vegetable Development. CRC Press. Florida.
8. Vishnu Swaroop, 2014. Vegetable Science & Technology in India. Kalyani Publishers. Ludhiana.

21HO2205 BREEDING AND SEED PRODUCTION OF FLOWER AND ORNAMENTAL CROPS

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Various conventional and advanced breeding techniques to develop hybrids
2. Production of different seeds using different methods
3. Stepwise methodology of seed certification process

Course outcomes:

On completion of this course, students will be able to

1. Perform simple breeding methods to produce hybrids
2. Comprehend the advanced methods of breeding
3. Appreciate the importance of heterosis and Cytoplasmic male sterility in seed production
4. Know the methodology of seed production and certification
5. Identify the different classes of registered seeds based on color of Tags
6. Produce different classes of registered seeds

Theory

History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops viz., Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia Heliconia, Lilium, Gaillardia, Petunia, *Hibiscus*, Bouganvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, crossandra, marigold, geranium, antirrhinum, china aster, orchids, anthurium, carnation, hibiscus etc. Breeding for disease resistance. Development of promising cultivars of important

ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

Practical

Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods.

References

1. Bose T.K, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers*. Partha Sankar Basu.
2. Bhattacharjee S.K and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur, India.
3. Callaway D.J and M.B. Callaway. 2000. *Breeding Ornamental Plants*. Timber Press
4. Singh A.K. 2014. *Breeding and Biotechnology of Flowers: Vol.02 Garden Flowers*. New India Publishing Agency
5. Vainstein A. 2002. *Breeding for Ornamental: Classical and Molecular Approaches*. Springer Publishers

21HO2206 SEED PRODUCTION OF VEGETABLE, TUBER AND SPICE CROPS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The history and growth of seed industry in India
2. The various seed production techniques of important vegetable, tuber and spice crops
3. The seed legislative laws in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand the role of seed industry & scope and importance of seed production in vegetable, tuber and spice crops
2. Acquire the knowledge on the role of weather parameters in seed production
3. Identify the suitable techniques for better seed production in vegetable, tuber and spice crops
4. Apply the various seed production techniques in vegetable, tuber and spice crops
5. Demonstrate the seed drying and extraction techniques
6. Understand the different seed legislative laws

Theory

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, color size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

References

1. Agarwal, P. K. 2010. *Techniques in Seed Science and Technology*. South Asian Publishers. New Delhi.
2. Arya, Prem Singh. 2003. *Vegetable seed Production Principles*. Kalyani Publishers. Ludhiana.
3. Fageria, M. S. 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers. Ludhiana.
4. Geetharani, P. 2007. *Seed Technology in Horticultural Crops*. NPH Publications. Jodhpur.
5. Hazra P. and Som M.G., 2009. *Vegetable seed production and Hybrid Technology*. Kalyani Publishers, Ludhiana.
6. Peter K.V. 2012 *Handbook of Herbs & Spices*. Woodhead Publishing. Elsevier. Cambridge. UK.
7. Prem Singh Arya, 2003. *Vegetable breeding, production and seed production*. Kalyani publishers, New Delhi.
8. Singh, Prabhakar. 2015. *Seed Production Technology of vegetable*. Daya Publishing House. New Delhi.
9. Singh, S.P. 2001. 1st edition, *Seed production of commercial vegetables*. Agrotech Publishing, Udaipur
10. Vanangamudi, K. 2010. *Vegetable Hybrid Seed Production and Management*. Agrobios. Jodhpur.

21HO2256 COMMERCIAL FLORICULTURE

Credits 2:0:1 (2+1)

Course objectives:

To impart knowledge on

1. Commercial flower crops and their market thrust.
2. Production technology of loose and cut flowers.
3. Harvesting and post-harvest handling of loose and cut flowers, concrete and other floral extraction methods.

Course outcomes:

On completion of this course, students will be able to

1. Identify the opportunities and constraints of floriculture industry in India
2. Demonstrate the packages of practices of commercial flowers under different agro- climatic conditions
3. Describe the technology of hi-tech cultivation of cut flowers
4. Recognize the importance and methods of post-harvest operation to enhance shelf life of flowers
5. Familiar with different type of pruning in roses and other cut flowers
6. Exhibit different pattern of flower arrangements

Theory

Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, crossandra, anthurium, dahlia, tuberose, bird of paradise, china aster, celosia, heliconia, gomphrena and gerbera for domestic and export market, production techniques of flowers, foliage and filler materials, growing of flowers under protected environments such as glass house, plastic house etc., postharvest technology of cut flowers in respect of commercial flower crops, concrete extraction and dye extraction in loose flowers, dehydration technique for drying of flowers, production techniques for bulbous.

Practical

Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

References

1. Bhattacharjee and De. L.C. 2004 – Advanced Commercial Floriculture. Vol. I & II.
2. Bhattacharjee, S.K., 2004 – Advanced commercial floriculture. Vol. I and II.
3. Bose, T.K., Yadav, L.P., Pal. P., Parthasarathy, V.A., Das. P., 2003. Commercial flowers. Vol.I and II. Nayaudyog, Kolkata-6.
4. Bose, T.K., Yadav, L.P., Pal. P., Parthasarathy, V.A., Das. P., 2003. Commercial flowers. Vol.I and II. Nayaudyog, Kolkata-6.
5. Bose, T. K. and P. Yadav. 1989. Commercial flowers. NayaPrakash, Calcutta
6. Foja S., 1997. Advances in Floriculture. Media Today Pvt Ltd., New Delhi-17
7. Prasad, S. and U. Kumar, 1998. Commercial floriculture. Agro Botanica. Bikaner - 334003.
8. Roy. A. L. 1992. Introduction of Floriculture. International Book Distributing Co., Lucknow.
9. Vishnu S. 1997. Ornamental Horticulture. Macmillan India Ltd., NewDelhi-2.

21HO2257 FUNDAMENTALS OF FOOD TECHNOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Basic concepts of food and its function
2. Food preparation techniques
3. Effect of micronutrients on health

Course Outcomes:

On completion of this course, students will be able to

1. Identify the composition and the nutritive value of different food.
2. Understand differences between well and malnourished populations.
3. Analyze the energy requirement of human system.
4. Apply the knowledge to design food based on the needs of the population.
5. Evaluate the effect of cooking on food preparations
6. Plan and prepare diets for various age groups

Theory

Food and its function, physico-chemical properties of foods, food preparation techniques, nutrition, relation of nutrition of good health. Characteristics of well and malnourished population. Energy, definition, determination of energy requirements, food energy, and total energy needs of the body. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

Practical

Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy, value proteins and fats of foods. Planning diet for various age groups.

References

1. Swaminathan, M. 1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
2. Swaminathan, M. 1985. Essential of Food and Nutrition Vol. II. BAPPCO, Bangalore.
3. Manoranjan, K. and S. Sangita. 1996. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
4. Srilakshmi. 2010. Food Science. New age International 978-81-224-2724-0.
5. Srilakshmi. 2005. Dietetics. New age International 978-81-224-1611-4.
6. Shankunthala, M. 1972. Foods-Facts, Principles & Procedure. The Eastern Press, Bengaluru.
7. Passmore, R. and M. A. Eastwood. 1986. Human Nutrition & Dietetics. ELBS 0443039194.
8. Anita, T. 1996. Food and Nutrition. Oxford 0198327668.
9. Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science, technology, and Quality Management. Kalyani Publishers 81-272-
10. Monoranjan, K. and S. Sangita. 2008. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
11. George, I. S. and D. L. Dennis. 1994. Chemistry for the Health Science. MacMillan 0-02-405161-6.
12. Masferton and Hurley. 1989. Chemistry Principles and Reactions. Saunders Golden Sunburst 0-03-005889-9.
13. Bettelheim and March. 1984. Introduction to General, Organic & Biochemistry. Harcourt Brace College Publishers 0030202175 Sounders College Publishing.
14. Gopalan, G., B.V. Ramasastri, and S. C. Balasubramnian. 1989. Nutritive value of the Indian Foods. National Institute of Nutrition, ICMR, Hyderabad. <http://www.fao.org/infoods/>
15. Swaminathan, M. 1988. Hand book of Food Science & Experimental Foods. Bappco publishers, Bangalore
16. Manay, S.N. and M. Shadaksharaswamy. 1998. Food-facts & Principles New Age International Publishers, New Delhi
17. Srilakshmi, B. 1995. Food Science. New Age International Publishers, New Delhi.

21HO2258 TEMPERATE VEGETABLE CROPS

Credit: 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. The importance of temperate vegetables in nutrition and national economy
2. The production technologies of temperate vegetable crops
3. Post-harvest handling and marketing of temperate vegetable crops

Course outcomes:

On completion of this course, students will be able to

1. Identify and describe hybrids and varieties of temperate vegetables
2. Understand the nutritional importance of cool season vegetables
3. Describe the scientific method of cultivation of major cool season vegetables
4. Apply remedial measures for nutritional and physiological disorders of temperate vegetables
5. Establish and maintain nursery for cool season vegetables
6. Postharvest management and marketing of temperate vegetables

Theory

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing of cabbage, cauliflower, knolkhol, sprouting broccoli, Brussels sprout, lettuce, palak, chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, vegetable kale.

Practical

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

Suggested Reading:

1. Thamburaj, S. 2014. Textbook of vegetable, tuber crops and Spices. ICAR, New Delhi
2. Choudhary, B. R., 2009. A Textbook on production technology of vegetables. Kalyani Publishers. Ludhiana.
3. Bose, T.K. 2002. Vegetable Crops. Nayaprakash. Kolkata.
4. Hazra, P. 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi.
5. Gopal Krishnan, T.R. 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
6. Kamath, K.V. 2007. Vegetable Crop Production. Oxford Book Company. Jaipur
7. Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
8. Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt. Ltd. New Delhi.
9. Yawalkar, K.S. 2008. Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur. 2004
10. Rana, M.K. 2008. Olericulture in India. Kalyani Publishers. Ludhiana
11. Hazra, P. 2006. Vegetable science. Kalyani Publishers. Ludhiana
12. Pratibha Sharma, 2007. Vegetables: Disease Diagnosis and Bio management. Aavishkar Publishers. Jaipur
13. Uma Shankar. 2008. Vegetable Pest Management Guide for Farmers. International Book Distribution Co. Publication. Lucknow.
14. Nath Prem. 1994. Vegetables for the Tropical Regions. ICAR New Delhi
15. Chadha, K.L. 1993. Advances in Horticulture. Malhotra publishing house. New Delhi
16. Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
17. Bose, T.K. 2003. Vegetable Crops. Nayaudyog publishers, Kolkata.
18. Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
19. Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

21HO2259 TEMPERATE FRUIT CROPS

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The scope and importance of cultivation and production of temperate fruit crops
2. Nutrient, weed and irrigation management of temperate fruit crops
3. Production constraints and management aspects of temperate fruit crop cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Identify the various kinds of temperate fruit crops
2. Remember commercial varieties and propagation methods of temperate fruits
3. Describe the cultivation aspects and cropping systems of temperate fruit crops
4. Elucidate the importance of high density planting, nutrient, weed and irrigation management of temperate fruit crops
5. Explain the various pruning and training practices of temperate fruit crops
6. Enumerate the production constraints and recommend remedial measures in temperate fruit crop cultivation

Theory

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements. propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queen's land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

References

1. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. Ed. by K.V. Peter, New India Publishing Agency, New Delhi.
2. Bose, T. K., Mitra, S. K. and Rathore. D. S. 1998. Temperate Fruits - Nayaprakash, Calcutta
3. Chattopadhyay, T.K., 2001. A Text Book on Pomology (4 volumes), Kalyani Publishers, Ludhiana

21HO2260 SPICES AND CONDIMENTS

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The scope and importance of cultivation and production of spices and condiments
2. The advances in the production technologies – irrigation, weed and nutrient management of spices and condiments
3. Postharvest management, marketing, and economics of spices and condiments cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Outline the concepts and propagation methods of spices and condiments
2. Understand the climate, soil requirement, nutrient and weed management of spices and condiments
3. Explain pruning and training methods, role of growth regulators and shade crops in the cultivation of spices and condiments
4. Acquire knowledge on essential oil extraction and value addition of spices and condiments
5. Describe harvest, postharvest and processing of spices and condiments
6. Know the marketing channels and economics of spices and condiments cultivation

Theory

History, scope and importance, Present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micro-propagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction, Marketing and economics of spice cultivation. Role of spice board and pepper, export promotion council, institutions and research centres in R&D. Crops: Cardamom, pepper, betel vine, ginger, turmeric, clove, nutmeg, cinnamon, kokum, star anise, flax seed, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

Practical

Spices: Identification of varieties: propagation, seed treatment, sowing, layout, planting, hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Quantitative and qualitative analysis of essential oil and oleoresins. Identification of adulterants in spice produce. Visit to few spice farms and spice based industries.

References

1. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.
2. Kumar, N, Md. Abdul Khader, P. Rangasamy, and Irulappan, I. 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil.
3. Nybe, E.V., Miniraj N. and Peter. K.V. 2007. Spices – Horticulture Science Series Vol. 5. New India Publishing Agency, New Delhi.
4. Shanmugavelu, K.G., Kumar N. and Peter K.V. 2005. Production Technology of Spices and Plantation Crops. Agrobios (India), Jodhpur.

21HO2261 ORNAMENTAL HORTICULTURE

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Production technology of ornamental crops
2. Design, establishment and maintenance of different types of gardens
3. Importance of flower arrangements, bonsai, terrarium vertical gardens and their maintenance

Course Outcomes:

On completion of this course, students will be able to

1. Understand the significance of ornamental horticulture and floriculture industry in national economy
2. Describe the cultivation aspects and maintenance of ornamental plants

3. Design landscape and maintenance of different garden features including turf grass
4. Design and establish different types of gardens
5. Develop color themes for various living/ nonliving garden components and utilize garden adornments
6. Apply principles of ornamental horticulture in the design of terrarium, bonsai, flower arrangement and their maintenance

Theory

History, definitions, scope of ornamental horticulture, aesthetic values, Floriculture industry, Importance, area and production, industrial importance of ornamental plants and flowers. Importance, classification, design values and general cultivation aspects for ornamental plants viz. Annuals, biennales herbaceous perennials, grasses and bulbous ornamentals. Shrubs, climbers, trees, indoor plants, palms and cycads, ferns and sellagenellas, cacti and succulents. Importance, design and establishment of garden features/components viz. hedge, edge, borders, flowerbeds, bridges, paths, drives, fences, garden walls, gates, carpet bed, arbour, Patio, decking, retaining walls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools, waterfalls, fountains, bog garden, avenue planting and children garden. Lawn types, establishment and maintenance. Importance of Garden adornments viz. floral clock, birdbath, statues, sculptures, lanterns, water basins, garden benches etc. Importance of flower arrangement, Ikebana, techniques, types, suitable flowers and cut foliage, uses of vertical garden, bottlegarden, terrariums, art of making bonsai, culture of bonsai and maintenance.

Practical

Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns and sellagenellas, Palms and cycads and Cacti and succulents. Planning and designing and establishment of garden features viz. lawn, hedge and edge, rockery, water garden, carpet bedding, shade garden, roof garden, Study and creation of terrariums, vertical garden, study and practice of different types of flower arrangements, preparation of floral bouquets, preparation of floral rangoli, etc., Study of Bonsai techniques, Bonsai practicing and training. Visit to nurseries and floriculture units.

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21HO2262 PLANTATION CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of plantation crops
2. The basics and advances in the production technology of plantation crops.
3. The role of various government organizations and industry involvement in production and processing of plantation crops

Course Outcomes:

On completion of this course, students will be able to

1. Prepare layout and mother plant selection of plantation crops
2. Describe the propagation methods of plantation crops
3. Understand various cultivation practices in plantation crops
4. Examine the physiological disorders and recommend remedial measures
5. Know the harvesting, postharvest handling and processing techniques of plantation crops
6. Estimate market potential and economics of plantation crop cultivation

Theory

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties. Propagation: principles and practices of seed, vegetative and micropropagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top

working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing. Yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, date palm and rubber.

Practical

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

References

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21HO2263 MEDICINAL AND AROMATIC CROPS

Credit: 2:0:1(2+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of medicinal and aromatic crops
2. Production technology of medicinal and aromatic plants
3. Various extraction processes of drugs and essential oil and their therapeutic uses

Course Outcomes:

On completion of this course, students will be able to

1. Describe the cultivation practices of Medicinal and Aromatic plants (MAP)
2. Remember the different pharmaceutical and therapeutic uses of MAPs
3. Evaluate the MAPs for medicinal and therapeutic uses
4. Explain the different extraction methods of drugs and essential oils from MAPs
5. Remember the different uses of MAPs in developing organic agricultural products
6. Understand the marketing channels and economics of drugs and essential oils of MAPs

Theory

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition (Bioactive compounds), extraction, use, quantification and identification of a few important medicinal and aromatic plants, Therapeutic and pharmaceutical uses of important species. Post-Harvest Practices: Harvesting and collection, Drying and Storage techniques, Value addition and Quality control (detection of adulterants) of drugs and essential oils. Medicinal Plants: Withania, periwinkle, Rauwolfia, Dioscorea, Isabgol, opium poppy Ammimajus, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum and other species relevant to the local conditions. Marketing and economics of drugs and essential oils in medicinal and aromatic plants. Bio prospecting of medicinal and aromatic plants for new medicines: Identification and collection of material by random and traditional (medicinal) approaches; Screening for particular bioactivities like insecticidal, weedcidal, anti-microbial and anti- tumor properties.

Practical

Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction identification and quantification of drugs and essential oils. Value added product-using MAPS.

References

1. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 2016. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil

2. Farooqi A.A and B.S. Sreeramu. 2015. Cultivation of Medicinal and Aromatic Crops. Universities Press. 3-6-747/1/A, Himayat nagar, Hyderabad -500029.
3. Jitendra Singh. 2014. Spices and Plantation Crops. Aavishkar Publishers, Distributors, Jaipur.
4. Herbs, Spices and Essential oils –Post harvest operations in developing countries. UNIDO and FAO 2005 — First published 2005
5. Extraction of Medicinal Plants , PDF notes developed by TNAU Professors
6. Extraction of Essential Oils from Aromatic Plants , PDF notes developed by TNAU Professors
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21HO2264 DRY LAND HORTICULTURE

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The importance and limitations of dryland horticulture
2. The soil and water conservation methods suitable for different agro climatic regions
3. The horticultural crops adapted for dryland cultivation and special cultivation techniques

Course Outcomes:

On completion of this course, students will be able to

1. Remember the scenario of dryland horticulture in India
2. Explain different water conservation techniques used
3. Acquire the knowledge on different crops suitable to dryland areas
4. Apply dryland farming techniques for various agro climatic regions
5. Identify the suitable drought resistant crops
6. Develop special package of practices for dryland horticultural crops

Theory

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encountered in dry lands. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc. Techniques and management of dry land horticulture. Watershed development, soil and water conservation methods-terraces, contour bunds, etc. Methods of control and impounding of run-off water-farm ponds, trenches, and macro catch pits, etc., *in-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelterbelts, mulches, antitranspirants, growth regulators etc. water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc. Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, rootstocks, *in-situ* grafting, deep pitting/planting, canopy management etc. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, Carissa, date palm, phalsa, fig, West Indian cherry and tamarind.

Practical

Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.

References

1. Awasthi O.P. and Saroj, P. L. 2008. Advances in Arid Horticulture. Production Technology of Arid and Semiarid Fruits. International Book Distributing Co.
2. Chundawat, B.S. 1990. Arid Fruit Culture. Oxford and IBH, New Delhi
3. Pradeep Kumar, T., Suma, B. Bhaskar, J. and Sathesan, K. N. 2008. Management of Horticultural Crops. New India Publishing Agency.
4. Sivamurugan, A.P. and Arun Kumar, R. 2008. Dryland Horticulture. Kalyani Publishers.
5. Taroj, P.L., Vashishtha, B. B. and Dhandar D. G. 2004. Advances in Arid Horticulture. Internal Book Distributing Co., Lucknow.

21HO2265 POTATO AND TUBER CROPS

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Economic importance and export potential of potato and tuber crops
2. Basic and modern cultural techniques to increase the yield and production of potato and tuber crops

3. Special practices, postharvest handling and marketing of potato and tuber crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe the cultivation practices of potato and other tuber crops
2. Understand the seed production technology of potato and tuber crops
3. Summarize the harvest, storage and post-harvest handling techniques of potato and tuber crops
4. Identify and offer solutions to biotic and abiotic constraints (nutrient deficiencies, pest, diseases, and physiological disorders)
5. Understand the export potential and marketing channels of potato and tuber crops
6. Estimate cost of cultivation of potato and tuber crops.

Theory

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices and yield economic of cultivation. Post-harvest handling and storage, field and seed standards, marketing. Crops to be covered – potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and intercultural use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing, seed collection, working out cost of cultivation, project preparation of commercial cultivation.

References

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2. Choudhary, B. R. 2009. A Text book on production technology of vegetables. Kalyani Publishers. Ludhiana.
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21. Bradshaw, J.E. 2010. Root and tuber crops. Springer Publications.

21HO2266 ORCHARD AND ESTATE MANAGEMENT

Credit: 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. The importance and objectives of orchard and estate management
2. The different cropping systems and their management in orchards and estates
3. Rejuvenation of old orchards through different methods

Course outcomes:

On completion of this course, students will be able to

1. Outline the basic designs of orchards and estates
2. Remember the different cropping systems in orchards and estates
3. Manage irrigation weed and nutrient applications in orchards and estates
4. Understand the importance of intercultural operations in orchards and estates
5. Identify cultivation constraints in the orchards and offer solutions
6. Rejuvenate old Orchards using traditional and modern methods

Theory

Orchard & estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of Horticultural crops.

Practical

Layout of different systems of orchard and estate. Soil management. Clean, inter, cover, mixed cropping and fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

References

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21HO2267 PRECISION FARMING AND PROTECTED CULTIVATION

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The protected cultivation of vegetables, fruits and flower crops
2. Hi-tech production technology of fruits, vegetables and flower crops
3. Precision production technology for important horticultural crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the need, benefits and challenges of protected cultivation of horticultural crops
2. Analyze the importance of various forms of mechanization in increasing crop productivity
3. Capable to integrate the internet of things, sensors, GIS and AI with agriculture crops to increase the agricultural production
4. Demonstrate different type of playhouses in different crop growing regions
5. Capable to identify the crops suitable for poly house cultivation
6. Able to describe different system of crop raising based on the concept of hydroponics

Theory

Precision farming – laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, mapping of soils and plant attributes, site-specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing

media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

Practical

Study of different types of greenhouses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization; Visit to commercial greenhouses; Economics of protected cultivation.

References

1. Singh, R. 2016. Handbook of Agricultural Engineering, ICAR, New Delhi.
2. Adams, C.R. Bandford, K.M. and Early, M.P. 1996. Principles of Horticulture. CBS publishers and distributors. Darya ganj, New Delhi.

21HO2268 POSTHARVEST MANAGEMENT OF HORTICULTURAL CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of postharvest losses and processing of fruits and vegetables
2. Pre-harvest factors and post-harvest qualities of important fruits and vegetables
3. Different storage, packaging and transport of horticultural crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe the importance of post-harvest technology in horticultural crops
2. Summarize the maturity indices of horticultural crops
3. Describe the post-harvest treatment of horticultural crops
4. Explain the pre-harvest factors responsible for postharvest deterioration of horticultural crops
5. Understand the different storage systems, and types of packaging of horticultural crops
6. Determine the modes of transport for shipping of horticultural crops

Theory

Importance of Postharvest Technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants. Pre harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process. Postharvest treatments of horticultural crops. Quality parameters and specifications. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Methods of storage for local market and export. Pre-harvest treatment and pre-cooling, prestorage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging. Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.

Practical

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops, spices and cut flowers by using different packaging materials, methods of storage and post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packing houses and cold storage units.

References

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12. Saraswathy, S. *et. al.* 2008. Post-harvest Management of Horticultural Crops. Agribios (India).81-7754-322-9.
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21HO2269 PROCESSING OF HORTICULTURAL CROPS

Credits 1:0:2 (1+2)

Course Objectives:

To impart knowledge on

1. Scope and importance of fruit and vegetable preservation
2. Principles and methods of preservation techniques of fruits and vegetables
3. Different government schemes and laws in import and export of processed horticultural produce

Course Outcomes:

On completion of this course, students will be able to

1. Understand the post-harvest losses and operations in India
2. Know the different unit operations in food processing industry
3. Remember the various preservation methods of horticultural crops
4. Describe the different preservation processes of fruits and vegetables
5. Understand the spoilage and quality control of processed products
6. Remember the food laws in export and import of processed horticultural produce

Theory

Importance and scope of fruit and vegetable preservation industry in India, food pipeline, losses in post-harvest operations, unit operations in food processing. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

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21HO2271 PRODUCTION TECHNOLOGY OF VEGETABLES AND SPICES

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Importance of vegetable and spices cultivation and prominent vegetables and spices in India
2. Production technology of tropical vegetable and spice crops
3. Plant protection measures in vegetable and spice crops

Course Outcomes:

On completion of this course, students will be able to

1. Explain the role of vegetables and spices in human nutrition and national economy
2. Apply production technologies of tropical vegetable and spice crops
3. Control pest, diseases, weed and physiological disorders in tropical vegetable and spices crops
4. Create and maintain kitchen garden and spices
5. Understand the harvesting methods of vegetable and spice crops
6. Apply post-harvest technology in vegetable and spice crops

Theory

Importance of vegetables and spices in human nutrition and national economy, kitchen gardening. Brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield. Physiological disorders of important vegetable and spices (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas; Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic; Root crops such as Carrot, Raddish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables).

Practical

Identification of vegetables & spice crops and their seeds. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables and spices. Fertilizers applications. Harvesting and preparation for market. Economics of vegetables and spices cultivation.

References

1. Gopalakrishnan, T.R., 2007. "Vegetable Crops" New India publishing agency, New Delhi.
2. James S. Shoemaker and Thomas Smith., 2006. "Culture of Veg., Growing" Asiatic.
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6. Uma Shankar Singh, 2008. "Indian vegetables", Anmol publications Pvt., Ltd., New Delhi.
7. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
8. Jitendra Singh. 2008. Spices and Plantation Crops. Aavishkar Publishers, Distributors, Jaipur.

21HO2272 PRODUCTION TECHNOLOGY FOR ORNAMENTAL CROPS, MAP AND LANDSCAPING

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Production technology of cut flowers, ornamental crops, MAP and turf management
2. Landscape use of trees, shrubs and climbers
3. Styles of landscape gardening and post –harvest handling of flower crops

Course Outcomes:

On completion of this course, students will be able to

1. Apply production technology of cut flowers, MAP and ornamental crops

2. Establish lawns and manage turf
3. Apply principles of landscaping using trees, shrubs and climbers
4. Design different styles of gardens
5. Handle flower crop harvesting and post-harvest operation and processing of MAPs
6. Perform training and pruning of ornamental plants

Theory

Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, liliun and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Processing and value addition in ornamental crops and MAPs produce.

Practical

Identification of ornamental plants. Identification of medicinal and aromatic Plants. Nursery bed preparation and seed sowing. Training and pruning of ornamental plants. Planning and layout of garden. Bed preparation and planting of MAP. Protected structures – care and maintenance. Intercultural operations in flowers and MAP. Harvesting and post-harvest handling of cut and loose flowers. Processing of MAP. Visit to commercial flower/MAP unit.

References

1. Desh Raj, 2014. Floriculture at a glance, Kalyani Publishers, New Delhi
2. Kumar, N. 2017. Introduction to horticulture, VIII Edition. Oxford & IBH Publishing co. Pvt. Ltd.
3. Mukherjee. 2008. Speciality Cut Flowers: Production Technologies. Naya Udyog Publisher.
4. Ponnuswami and Sowmeya. 2015. Flowers and fillers Production technology, Aavishkar Publishers, Jaipur.
5. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
6. Principles of Landscape Gardening – Agrimoon.com

21HO2273 POST-HARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of postharvest processing of fruits and vegetables
2. Different preservation techniques and value addition process of important fruits and vegetables
3. Government schemes and laws regulating import and export of fresh fruits and vegetables

Course Outcomes:

On completion of this course, students will be able to

1. Remember the different post-harvest management of important fruits and vegetables
2. Understand the factors causing post-harvest losses in fruits and Vegetables
3. Explain about the different value addition process of important fruits and vegetables
4. Analyze the market, demand and supply chain for important fruits and vegetables
5. Recommend suitable storage structures and packaging methods for postharvest management of fruits and vegetables
6. Demonstrate knowledge about the different government schemes and laws in import and export of fruits and vegetables

Theory

Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post-harvest losses. Importance and scope of fruit and vegetable preservation industry in India, food pipeline, losses in post-harvest operations, unit operations in food processing. Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning concepts and standards, packaging of products. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation

with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Applications of different types of packaging, containers for shelf-life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Quality evaluation of products - physico-chemical and sensory. Visit to processing unit/ industry. Equipment used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

References

1. Verma, L. R. and V. K. Joshi, 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.
2. FAO - Training Manual No.17/2. 2007. Prevention of post-harvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.
3. Morris, T. N. 2006. Principles of Fruit Preservation. Biotech Books, Delhi. 81-7622-116-3.
4. Rathore N.S., G.K. Mathur and S.S. Chasta 2012. Post-Harvest Management and Processing of Fruits and Vegetables. The Energy And Resources Institute
5. Srivastava, R. P. and S. Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.

21HO2274 PRINCIPLES OF FOOD SCIENCE AND NUTRITION

Credit 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. The basic concepts of food science, food chemistry and food microbiology.
2. The principles and methods of food processing and microbial food spoilers.
3. Malnutrition, nutritional disorders and planning a balanced/modified diet.

Course Outcomes:

On completion of this course, students will be able to

1. Explain the concepts of food science.
2. Enumerate and describe food composition and food chemistry
3. Demonstrate the principles and methods of food processing.
4. Analyze the methods to control microbes and preserve food
5. Identify the nutritional disorders
6. Design balanced/modified diet to meet consumer needs.

Theory

Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.); Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions); Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.); Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/modified diets, Menu planning, New trends in food science and nutrition.

References

1. Coulter, T.P 'Food- The chemistry of its components', 2nd edition. Royal Society, London 1992.
2. Sivasanker, B. Food processing and preservation", prentice Hall of India Pvt. Ltd. New Delhi, ISBN 9788120320864, 2002
3. Frazier W.C. and D.C Westhoff, Food Microbiology", 4th Edition, McGraw- Hill Book Co., New York- 2008

21HO2305 SOIL, WATER AND PLANT ANALYSIS

Credit: 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. Soil fertility, soil biology and problematic soils
2. Analysis and interpretation of plant nutrient content and quality of irrigation water

3. Soil and water pollution and reclamation

Course outcomes:

On completion of this course, students will be able to

1. Describe the methods of soil, plant and water sampling and processing for analysis
2. Evaluate the fertility status and biology of the soil
3. Identify and plan the management strategies for the problematic soils
4. Analyse and interpret the nutrient status of the plants
5. Evaluate the suitability of irrigation water and plan appropriate management strategies
6. Detect soil and water pollutants and recommend remedial measures

Theory

Methods of soil and plant sampling and processing for analysis. Characterization of hydraulic mobility, diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential. Use of radiotracer techniques in soil fertility evaluation. Soil microorganisms and their importance. Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values. Quality of irrigation water. Radiotracer technology application in plant nutrient studies. Rapid tissue tests for soil and plant. Management of poor quality irrigation water in crop management. Soil and Water pollution.

Practical

Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Estimation of available macro and micronutrient elements in soils and their contents in plants. Irrigation water quality analysis, determination of pH and EC in irrigation water samples, determination of carbonates and bicarbonates in soil and irrigation water, determination of calcium and magnesium in soil and irrigation water. Determination of N, P, K, Ca, Mg, sand micronutrients in plant samples. Determination of sodium, potassium, chlorine and boron in irrigation water.

References

1. Tandon, H.L.S. 2013, Methods of analysis of soil, plant, water and fertilizers. FDCO, New Delhi.
2. Yawalkar, K. S. Agarwal, J. P. and Bokde, S., 1977. Manures and Fertilizers. Agri-Horticultural Publishing House, Nagpur.
3. Sehgal J. A., 2005. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
4. Jaiswal, P.C., 2006. Soil, Plant and Water Analysis (2nd Edition), Kalyani Publishers, Ludhiana.
5. Jackson M. L, 1967. Soil Chemical Analysis, Oxford and IBH Publishing Co., New Delhi.
6. Richards L A, 1968. Diagnosis and Improvement of Saline and Alkaline Soils. Oxford and IBH publishing Co. New Delhi (USDA Hand Book No. 60)
7. Chopra S.C. and Kanwar, J. S 1976. Analytical Agricultural Chemistry, Kalyani Publishers, Ludhiana.
8. Piper, C. S., 2014, Soil and plant analysis, Scientific publishers India.
9. Mushtaq A. Wan., 2014, Soil, plant and water analysis manual. Agrotech publishing company, Udaipur.
10. Gupta, P. K. 2013, Soil, plant, water and fertilizer analysis. Agrobios, India.
11. Durai. M. V. 2014, Hand book of Soil, plant, water, fertilizers and manure analysis. New India Publishing Agency.

21HO2306 SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of nutrients in horticultural crop production
2. Soil fertility evaluation and soil testing methods
3. The concept and management of Integrated Nutrient Management

Course Outcomes:

On completion of this course, students will be able to

1. Elucidate the role of essential nutrients in horticultural crops
2. Identify nutrient deficiency symptoms in horticultural crops
3. Elaborate the role of microorganisms in enriching soil fertility by decomposing organic matter
4. Remember soil testing and soil fertility evaluation procedures
5. Understand the importance of bio-fertilizers in crop nutrition
6. Describe the concept of Integrated Nutrient Management in restoring soil fertility

Theory

Introduction to soil fertility and productivity- factors affecting soil fertility and productivity. Essential plant nutrient elements-functions, deficiency systems, transformations and availability. Acid, calcareous and salt

affected soils – characteristics and management. Soil organic matter, Role of microorganisms in organic matter-decomposition – humus formation. Importance of C: N ratio and pH in plant nutrition, soil-buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Plant nutrient toxicity symptoms and remedial measures. Soil test crop response and targeted yield concept. Biofertilizers. Nutrient use efficiency and management. Secondary and micronutrient fertilizer. Fertilizer control order. Manures and fertilizers. Classification and manufacturing process. Properties, fate of major, and micronutrient in soils. Fertilizer use efficiency and management. Effect of potential toxic elements in soil productivity. Application of advanced techniques in fertilizer recommendation and application - Remote sensing, GIS, GPS, Precision agriculture, big data and Cloud computing.

Practical

Analysis of soil for organic matter, available N, P and K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils. Estimation of organic carbon content in soil. Determination of Boron and chlorine content in soil. Determination of Calcium, Magnesium and Sulphur in soil. Sampling of organic manure and fertilizer for chemical analysis. Physical properties of organic manure and fertilizers. Total nitrogen in urea and farmyard manure. Estimation of ammonical nitrogen and nitrate nitrogen in ammonical fertilizer. Estimation of water soluble P_2O_5 , Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate. Visit to fertilizer testing laboratory.

References

1. John L. Havlin, Samuel L. Tisdale, Werner L. Nelson and James D. Beaton. 2016. (8th Edn). Soil Fertility and Fertilizers. Pearson Publishers. London.
2. Kolay, A.K. 2007. Manures and Fertilizers. Atlantic Publishers & Distributors (P) Ltd., Chennai.
3. Millar, C. E., 1955. Soil Fertility. John Wiley Publishers, New York
4. Panda, S.C. 2017. Soil Fertility and Nutrient Management. Agrobios (India) Publishers, Jodhpur.
5. Parker and Harold. J. 1991. Environmental handbook for fertilizer and agrichemical dealers. Tennessee Valley Authority, National Fertilizer and Environmental Research Center.
6. Yawalkar K.S, Agarwal J.P and Bokde S. 2002. Manures and Fertilizers (Ninth Edition). Agri-Horticultural Publishing House, Nagpur- 440010, India.

21HO2352 DISEASES OF FRUIT, PLANTATION, MEDICINAL AND AROMATIC CROPS

Credits: 2:0:1(2+1)

Course objectives:

To impart knowledge on

1. Etiology, damage symptoms, mode of spread and survival of plant diseases
2. Host parasite relationship of important plant diseases
3. Integrated management of important plant diseases

Course outcomes:

On completion of this course, students will be able to

1. Summon up various plant diseases and their causal organisms in field and horticultural crops
2. Identify sign and symptoms for detection of pathogens and disease
3. Determine the prevalence, epidemiology and factors affecting disease development
4. Comprehend the disease cycle of various plant diseases
5. Analyze the host pathogen interaction on disease development
6. Acquaint with integrated methods of disease management, use of biological agents and chemicals in disease management

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, croton, datura, dioscorea, mint, opium, *Solanum khasianum* and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

References

1. Arjunan, G. Karthikeyan, G., Dinakaran, D., and Raguchander, T. 1999. Diseases of Horticultural Crops, AE Publications, Coimbatore.

2. Rangaswamy, C. 2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi.

21HO2353 DISEASES OF VEGETABLE, ORNAMENTAL AND SPICE CROPS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The etiology and symptoms of diseases of the vegetables, flowers, ornamental and spice crops
2. The mode of spread and epidemiology of diseases in vegetables, flowers, ornamental and spice crops
3. The integrated disease management and post-harvest disease management practices

Course Outcomes:

On completion of this course, students will be able to

1. Understand the etiology of the different diseases of vegetables, flowers, ornamental and spice crops
2. Identify the symptoms of diseases and their mode of spread
3. Apply the various disease management practices of vegetables, flowers, ornamental and spice crops
4. Develop an integrated disease management practices for framing the crop protection strategies
5. Diagnose the important post-harvest diseases
6. Develop a disease management practices for protected cultivation systems and for the post-harvest diseases

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerbera, anthurium, geranium. Important post-harvest diseases of vegetables, ornamental crops and their management.

Practical

Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops in field as well as in protected cultivation.

References

1. Srikant Kulkarni, Yashoda R. Hedge. Diseases of Plantation crops and their management-, Agrotech publication Academy
2. S.L. Godara, BBS Kapoor, B.S. Rathore. Disease management of spice crops-, Madhu Publications.
3. L.DarwinChristdhar Henry and H.LewinDevasahayam Crop diseases: Identification, Treatment and Management. An Illustrated Handbook –, New India publishing Agency
4. Singh, R.S. 1994. Diseases of Vegetable Crops. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi y Singh, R.S 1996. Plant Diseases. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
5. Sohi, H.S. 1992. Diseases of Ornamental plants in India. ICAR, New Delhi
6. RangaSwamy, G. 1988. Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Saha, L.R. 2002. Hand Book of Plant Diseases. Kalyani Publishers
8. Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. Diseases of Horticultural Crops. .Dept. of Plant Pathology, Tamilnadu Agricultural University Coimbatore.

21HO2452 WATER MANAGEMENT IN HORTICULTURAL CROPS

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Soil, water and plant relationships and soil moisture constant with special reference to horticultural plants
2. Working principles of water measuring devices and water management tools
3. The impact of water on horticultural crop production and its management

Course Outcomes:

On completion of this course, students will be able to

1. Understand the role of water relation in metabolic and physiological functions of plants
2. Understand the water requirement of horticultural crops
3. Schedule irrigation for horticultural crops based on scientific knowledge gained
4. Apply the irrigation management structures for efficient water use
5. Analyze the different water management problems
6. Outline the layout of different irrigation systems

Theory

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

Practical

Measurements of irrigation water by using water - measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning, scheduling and soil moisture conservation practices.

References

1. Rao, Y.P. and S.R. Bhaskar. 2008. Irrigation Technology. Theory and practice. Agrotech publishing Academy, Udaipur.
2. Dilip Kumar Mujmdar. 2004. Irrigation Water Management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
3. S.V. Patil and G.R. Rajakumar. 2016. Water Management in Agriculture and Horticultural Crops. Satish serial publishing House, New Delhi.
4. Carr M. K. V. and Elias Fereres. 2012. Advances in Irrigation Agronomy. Cambridge University Press.
5. Michael, A.M. 2015. Irrigation Theory and Practices. Vikas publishing house Pvt., Ltd.

21HO2504 ELEMENTARY PLANT BIOTECHNOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The basic Concepts of Biotechnology
2. Micro propagation and genetic engineering techniques in plants
3. Nanotechnology and its application in plants

Course Outcomes:

On completion of this course, students will be able to

1. Understand the structure and function of prokaryotic and eukaryotic cells.
2. Conceptualize the mechanism gene replication, transcription, translation
3. Apply micro propagation techniques to propagate plants
4. Understand the various genetic engineering tools for plant improvement
5. Detect the transgenic using immunological techniques and markers.
6. Comprehend the importance of nanoparticles and its use in agriculture

Theory

Concepts of plant biotechnology: history of plant tissue culture and plant genetic engineering. Scope and importance in crop improvement: totipotency and morphogenesis, nutritional requirements of in-vitro cultures. Techniques of in-vitro cultures, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, test tube fertilization, endosperm culture, factors affecting above in-vitro culture; applications and achievements; somaclonal variation, types, reasons: somatic embryogenesis and synthetic seed production technology; protoplast isolation, culture, manipulation and fusion; products of somatic hybrids and cybrids, applications in crop improvement. Genetic engineering; restriction enzymes; vectors for gene transfer – gene cloning – direct and indirect method of gene transfer – transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples, Nano toxicology and safety.

Practical

Requirements for plant tissue culture laboratory; techniques in plant tissue culture. Media components and preparations; sterilization techniques and inoculation of various explants; aseptic manipulation of various explants; callus induction and plant regeneration; micro propagation of important crops; anther, embryo and endosperm culture; hardening / acclimatization of regenerated plants; somatic embryogenesis and synthetic seed

production; isolation of protoplast; demonstration of culturing of protoplast;. Demonstration of isolation of DNA; demonstration of gene transfer techniques, direct methods; demonstration of gene transfer techniques, indirect methods; demonstration of confirmation of genetic transformation; demonstration of gel electrophoresis techniques. Green synthesis of Nano particles and their size characterization.

References

1. Singh, B D, 2004. Biotechnology Expanding Horizons 2nd Edn. Kalyani Publishers, New Delhi.
2. Gupta, P.K., 2015. Elements of Biotechnology 2nd Edn. Rastogi and Co., Meerut.
3. Razdan M K, 2014. Introduction to plant Tissue Culture 2nd Edn. Science Publishers, inc. USA.
4. Gautam V K, 2005. Agricultural Biotechnology. Sublime Publications
5. Thomar, R.S., M.V., Parakhia, S.V Patel,. and B.A Golakia. 2010. Molecular markers and Plant Biotechnology, New Publishers, New Delhi.
6. Purohit, S.S., 2004. A Laboratory Manual of Plant Biotechnology 2nd Edn. Agribios, India.
7. Singh, B.D. 2012. Plant Biotechnology. Kalyani publishers, Ludhiana
8. Bilgrami, K.S. and Pandey, A.K.1992. Introduction to Biotechnology. CBS Pub. New Delhi
9. Gupta, P.K. 1994. Elements of Biotechnology. Rastogi Pub. Meerut.
10. Chahal, G.S. and Gosal, S.S.2003. Principles and Procedures of Plant Approaches Breeding Biotechnological and Conventional. Narosa Publishing House, New Delhi

21AG3001 MODERN CONCEPTS IN CROP PRODUCTION

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. The concepts of soil management and crop production.
2. The factors affecting crop production and yield.
3. The modern crop production technologies.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the crop production techniques and crop growth in relation to environment.
2. Address various factors affecting crop production and yield.
3. Know the effective ways of soil and nutrient management.
4. Recognize and identify effective ways to overcome the environmental stresses affecting crop growth and yield.
5. Learn the ways for effective utilization of farm resources, diversification of crop productions and maximizing the farm income.
6. Gain knowledge on new technologies and trends in agriculture for maximizing crop yield and farm income in a sustainable way.

Theory

Crop growth analysis in relation to environment; Agro-ecological zones of India; Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit; Effect of lodging in cereals; Physiology of grain yield in cereals; Optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modelling for desired crop yield; Scientific principles of crop production; Crop response production functions; Concept of soil plant relations; Yield and environmental stress; Integrated farming systems, Organic farming and resource conservation technology including modern concept of tillage; Dry farming; Determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; Precision agriculture.

References

1. Balasubramaniyan, P and Palaniappan, S.P. (2001). *Principles and Practices of Agronomy*. Agrobios.
2. Fageria, N.K. (1992). *Maximizing Crop Yields*. Marcel Dekker.
3. Havlin, J.L., Beaton, J.D., Tisdale S.L and Nelson, W.L. (2006). *Soil Fertility and Fertilizers*. (7th Ed.). Prentice Hall.
4. Paroda, R.S. (2003). *Sustaining our Food Security*. Konark Publications.
5. Reddy, S.R. (2000). *Principles of Crop Production*. Kalyani Publications.
6. Sankaran, S and Mudaliar, T.V.S. (1997). *Principles of Agronomy*. The Bangalore Printing and Publications.
7. Singh, S.S. (2006). *Principles and Practices of Agronomy*. Kalyani Publications.

21AG3002 PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. The importance of soil fertility, nutrients and its influence on crop growth, development and yield.
2. Chemical fertilizers and organic manures as sources of plant nutrients.
3. The integrated approach on plant nutrient management and the sustainable crop production.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of soil fertility management and crop growth.
2. Know the role of various nutrients in crop growth, development and yield.
3. Recognize the composition of various chemical fertilizers and could recognize its impact on crop production.
4. Derive a thorough knowledge on various organic manure productions and its application.
5. Develop a holistic knowledge on sustainable nutrient management practices for sound farming ecosystem.
6. Learn the methodologies for determining the soil nutrient levels and the crop nutrient uptake.

Theory

Factors affecting soil fertility and productivity; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming: basic concepts and definitions; criteria of essentiality of nutrients; essential plant nutrients and their functions; nutrient deficiency symptoms; transformation and dynamics of major plant nutrients; preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers, other organic concentrates, their composition, availability and crop responses; use of vermicompost and residue wastes in crops; recycling of organic wastes and residue management; commercial fertilizers, their composition, relative fertilizer value and cost; fertilizer mixtures and grades; crop response to different nutrients and residual effects; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions; time and methods of manures and fertilizers application; foliar application of nutrients and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management.

Practical

Determination of soil pH, EC, organic C, total N and available N,P,K in soils Determination of total N, P, K and S in plants; Interpretation of interaction effects and computation of economic and yield optima.

References

1. Brady, N.C and Weil, R.R., (2002). *The Nature and Properties of soils*. (13th Ed). Pearson Edu.
2. Fageria, N.K., Baligar, V.C and Jones, C.A. (1991). *Growth and Mineral Nutrition of Field Crops*. Marcel Dekker.
3. Havlin, J.L., Beaton, J.D., Tisdale, S.L and Nelson, W.L. (2006). *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
4. Prasad, R and Power, J.F. (1997). *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
5. Yawalkar, K.S., Agrawal, J.P and Bokde, S. (2000). *Manures and Fertilizers*. Agri-Horti Publications.

21AG3003 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Different types of weeds and its impact on crop production.
2. Herbicides and its application in weed control.
3. Different methods of weed control in crop production.

Course Outcomes:

On completion of this course, students will be able to

1. Identify different types of weeds and their ecosystem.
2. Understand the weeds survival mechanisms.
3. Recommend herbicides for weed management in field crops.
4. Adopt different weed control methods for crop production.
5. Apply integrated weed management practices.
6. Workout the economics of weed control.

Theory

Weed biology and ecology, crop-weed competition and allelopathy; principles and methods of weed control and classification; weed indices; herbicides introduction and their history; classification of herbicides based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides; herbicide structure; activity

relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; bio-herbicides, myco-herbicides and allelo-chemicals; degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation; weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control; integrated weed management; cost-benefit analysis of weed management.

Practical

Identification of important weeds of different crops; preparation of a weed herbarium; weed survey in crops and cropping systems; crop-weed competition studies; preparation of spray solutions of herbicides for high and low-volume sprayers; study on various types of spray pumps and nozzles and calculation of swath width; economics of weed control; herbicide resistance analysis in plant and soil; bioassay of herbicide resistance; calculation of herbicidal requirement.

References

1. Aldrich, R.J and Kramer, R.J. (1997). *Principles in Weed Management*. Panima Publications.
2. Ashton, F.M and Crafts, A.S. (1981). *Mode of Action of Herbicides*. (2ndEd.) Wiley Inter-Science.
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21AG3004 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. The importance of water and its significance in crop production.
2. The soil-water-plant relationships.
3. Different methods of irrigation management in crop production.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the role of water in relation to metabolic and physiological functions of plants.
2. Know the water requirements for field crop cultivations.
3. Adopt different irrigation management strategies.
4. Apply the irrigation management principles for efficient water use.
5. Address different water management problems in irrigation.
6. Outline the layout of different irrigation systems.

Theory

Water and its role in plants; water resources of India, major irrigation projects and extent of area under irrigated crops in India and different states; soil water movement in soil and plants; transpiration; soil-water-plant relationships: water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Soil, plant and meteorological factors determining the water needs of crops; irrigation scheduling, depth and methods of irrigation; micro-irrigation system; fertigation; management of water in controlled environments and poly-houses; water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency, water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

Measurement of soil water potential by using tensio-meter, pressure plate and membrane apparatus; Soil-moisture characteristics curves; Water flow measurements using different devices; Determination of irrigation requirements; Calculation of irrigation efficiency; Determination of infiltration rate; Determination of saturated / unsaturated hydraulic conductivity.

References

1. Lenka, D. (1999). *Irrigation and Drainage*. Kalyani Publications
2. Michael, A.M. (1978). *Irrigation: Theory and Practice*. Vikas Publications.
3. Paliwal, K.V. (1972). *Irrigation with Saline Water*. IARI Monograph, New Delhi.
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6. Reddy, S.R. (2000). *Principles of Crop Production*. Kalyani Publications
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21AG3005 AGRO-METEOROLOGY AND CROP WEATHER FORECASTING

Credits: 3 (2+1)

Course Objectives:

To impart Knowledge on

1. Agro-Meteorology and Climate Change.
2. Crop Weather Forecasting.
3. Agro-meteorological observatory and the usages of various meteorological instruments.

Course Outcomes:

On completion of this course, student will be able to

1. Understand the significance of agricultural meteorology, climate and weather.
2. Know the various atmospheric weather variables and its significance in crop production.
3. Perceive crop weather relationships for efficient crop production.
4. Acquire knowledge on weather forecasting techniques.
5. Gains hands-on knowledge on the functioning of agro-meteorological observatory.
6. Address the effect of climate change on crop production.

Theory

Agro-meteorology-aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind; characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies and radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature; temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation; measures of atmospheric temperature and relative humidity, vapour pressure and their relationships; evapo-transpiration and meteorological factors determining evapo-transpiration; modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation; weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; climate change and its impact on agriculture.

Practical

Visit to agro-meteorological observatory; learning the procedures for recording sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure; measurement of solar radiation outside and within plant canopy; measurement/estimation of evapo-transpiration by various methods; measurement/estimation of soil water balance; rainfall variability analysis; determination of heat-unit requirement for different crops; measurement of crop canopy temperature; measurement of soil temperatures at different depths; remote sensing and familiarization with agro-advisory service bulletins; study of synoptic charts and weather reports, working principle of automatic weather station.

References

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2. Critchfield, H.J. (1995). *General Climatology*. Prentice Hall of India.
3. Das, P.K. (1968). *The Monsoons*. National Book Trust Publications.
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21AG3006 CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Prevailing cropping systems in the country.
2. Advanced agronomic practices for different cropping systems to improve their productivity.

3. Sustainable Agriculture practices.

Course Outcomes:**On completion of this course, students will be able to:**

1. Understand different cropping systems and ways to effectively manage resources under different cropping systems.
2. Develop deep insights on crop interactions under cropping systems.
3. Gain knowledge on the importance of sustainable agriculture.
4. Relate sustainable agriculture with conventional agriculture in a scientific manner.
5. Imbibe knowledge on the importance of crop diversification and the sustainability of farm operations.
6. Apply the knowledge of sustainable crop production in effectively guiding farmers.

Theory

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use; concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and inter cropping; mechanism of yield advantage in inter cropping systems; above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in inter cropping; role of non-monetary inputs and low cost technologies; research needs on sustainable agriculture; crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system; plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Practical:

Preparation of cropping scheme - working out input requirements for crops, cropping systems - preparation of calendar of operations for wetland, irrigated upland and dry land cropping system - visit to cropping system experiments - working out indices for evaluation of cropping systems - visit to different units: dairy, goat, poultry, fishery. Mushroom, sericulture and biogas - study on evaluation indicators on farming system - preparation of integrated farming system models for different eco-systems - on farm field visit - analysis of farming system models.

References

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2. Panda, S.C. (2003). *Cropping and Farming Systems*. Agrobios.
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21AG3007 DRYLAND FARMING AND WATERSHED MANAGEMENT

Credits: 3 (2+1)

Course Objectives:**To impart knowledge on**

1. Basic concepts and practices of dryland farming.
2. Adaptation and mitigation strategies, crop planning and management techniques under dryland conditions.
3. Soil moisture conservation and drought management.

Course Outcomes:**On completion of this course, students will be able to:**

1. Understand sustainable agriculture practices under dryland conditions.
2. Correlate soil and climatic conditions of drylands for successful crop production.
3. Explain the various crop management techniques and the adaptation strategies for dry land agriculture.
4. Formulate contingent water planning for aberrant weather conditions.
5. Learn the different types of watershed management strategies.
6. Apply the knowledge of different water conservation methods and water management strategies for dryland farming.

Theory

Definition, concept and characteristics of Dryland farming; Dryland versus Rainfed farming; significance and dimensions of Dryland farming in Indian Agriculture; soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dryland areas; types of drought, characterization of

environment for water availability; crop planning for erratic and aberrant weather conditions; stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dryland areas; mid contingent plan for aberrant weather conditions; tillage, tith, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use; concept of watershed resource management, problems, approach and components.

Practical

Seed treatment, seed germination and crop establishment in relation to soil moisture contents; moisture stress effects and recovery behaviour of important crops; estimation of moisture index and aridity index; spray of anti-transpirants and their effect on crops; collection and interpretation of data for water balance equations; water use efficiency; preparation of crop plans for different drought conditions; study of field experiments relevant to dryland farming; visit to dryland research stations and watershed projects

References

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3. Dhruv Narayan, V.V. (2002). *Soil and Water Conservation Research in India*. ICAR.
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21AG3008 AGRONOMY OF MAJOR CEREALS AND PULSES

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Major cereals and pulses cultivated in India.
2. Crop husbandry of cereals and pulses.
3. Growth indices of cereals and pulses cultivated in India.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the geographical distribution, varietal improvements and the adaptability of major cereals and pulses cultivated in India
2. Acquire knowledge on crop production technologies for rabi cereals.
3. Perceive knowledge on crop production technologies for kharif cereals.
4. Manage the crop production technologies for rabi pulses.
5. Work out the crop production technologies for kharif pulses.
6. Apply the acquired knowledge to guide the farmers for cultivating cereals and pulses.

Theory

Origin, history, area, production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of i) Rabi cereals; ii) Kharif cereals; iii) Rabi pulses and iv) Kharif pulses.

Practical

Phenological studies at different growth stages of crop; Estimation of crop yield on the basis of yield attributes; Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; Working out growth indices (CER, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops; Estimation of protein content in pulses; Planning and layout of field experiments; Judging of physiological maturity in different crops. Intercultural operations in different crops; Determination of cost of cultivation of different crops; Working out harvest index of various crops; Study of seed production techniques in various crops; Visit of field experiments on cultural, fertilizer, weed control and water management aspects; Visit to nearby villages for identification of constraints in crop production.

References

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3. Jeswani, L.M and Baldev, B. (1997). *Advances in Pulse Production Technology*. ICAR.
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21AG3009 AGRONOMY OF OILSEED, FIBER AND SUGAR CROPS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Oilseed, fibre and sugar crops cultivated in India.
2. Crop husbandry of oilseed, fibre and sugar crops.
3. Growth indices of oilseed, fibre and sugar crops.

Course Outcomes:

On completion of this course, students will be able to:

1. Understand the geographical distribution, varietal improvements and the adaptability of major oilseed, fibre and sugar crops cultivated in India.
2. Acquire knowledge on crop production technologies for rabi oilseeds.
3. Practice on crop production technologies for kharif oilseeds.
4. Implement crop production technologies for fibre crops.
5. Work out crop production technologies for sugar crops.
6. Apply the acquired knowledge to guide the farmers for cultivating oilseed, fibre and sugar crops.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of: (i) rabi oilseeds: rapeseed and mustard, linseed, etc.(ii) kharif oilseeds: groundnut, sesame, castor, sunflower, soybean etc. (iii) fibre crops: cotton, jute, sun hemp etc.; (iv) sugar crops: sugar-beet and sugarcane.

Practical

Cutting of sugarcane setts, its treatment and methods of sowing; tying and propping of sugarcane; determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice; phenological studies at different growth stages of crop; cotton seed treatment; working out growth indices (LER, CGR, RGR, NAR, LAD) aggressivity, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems; judging of physiological maturity in different crops and working out harvest index; working out cost of cultivation of different crops; estimation of crop yield on the basis of yield attributes; determination of oil content in oilseeds and computation of oil yield; estimation of quality of fibre of different fibre crops; visit of field experiments on cultural, fertilizer, weed control and water management aspects; visit to nearby villages for identification of constraints in crop production

References

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2. Das, P.C. (1997). *Oilseed Crops of India*. Kalyani Publishers
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21AG3010 AGRONOMY OF FODDER AND FORAGE CROPS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Crop husbandry of different forage and fodder crops.

2. The preservation of fodder crops.
3. Processing and value addition in forage and fodder crops.

Course Outcomes:

On completion of this course, students will be able to:

1. Know about the adaptation, distribution, varietal improvements and quality characteristics of fodder crops.
2. Know the significance of forage crops.
3. Acquire knowledge on crop production technologies for different fodder crops and forage crops.
4. Perceive the methods of preserving the fodders.
5. Understand the methods of processing and enrichment of fodders.
6. Recommend different fodder and forage crops in reference to the nutritive values and animal health.

Theory

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, bajra, guar, cowpea, oats, barley, berseem, senji, lucerne etc; Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops /grasses-lime, napier grass, *Panicum*, *Lasiurus*, *Cenchrus* etc.; Year-round fodder production and management, preservation and utilization of forage and pasture crops; Principles and methods of hay and silage making, chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; Value addition of poor quality fodder, use of physical and chemical enrichments and biological methods for improving nutrition; Economics of forage cultivation uses and seed production techniques.

Practical

Farm operations in raising fodder crops; Canopy measurement, yield and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder and forage crops; Anti-quality components like HCN in sorghum and such factors in other crops; Hay and silage making and economics of their preparation.

References

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5. Singh, C., Singh, P and Singh, R. (2003). *Modern Techniques of Raising Field Crops*. Oxford and IBH Publication.
6. Tejwani, K.G. (1994). *Agroforestry in India*. Oxford and IBH Publication.

21AG3011 AGROSTOLOGY AND AGROFORESTRY

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Grassland ecosystems.
2. Agroforestry systems in sustaining the land productivity.
3. Crop production technologies in agro-forestry and agrostology systems.

Course Outcomes:

On completion of this course, students will be able to:

1. Understand the grassland ecosystem and its importance in India
2. Learn about the renovation, establishment and management of grasslands.
3. Apply the knowledge of agrostology and pasture management in guiding farmers.
4. Imbibe knowledge on the different agroforestry systems and its importance in sustainable crop production.
5. Perceive the crop production technologies under agro-forestry systems.
6. Developing agro forestry in guiding farmers for sustainable production.

Theory

Agrostology: definition and importance: principles of grassland ecology: grassland ecology–community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands; importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation of natural pastures, cultivated pastures; and common pasture grasses; agroforestry: definition and importance; agro-forestry systems: Agri-silviculture, silvipasture, agri-silvipasture, agri-horticulture, aqua-silviculture, alley cropping and energy plantation; crop production technology in agro-forestry and agrostology system; silvi-pastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-

forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

Practical

Preparation of charts and maps of India showing different types of pastures and agro-forestry systems; identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry; seed treatment for better germination of farm vegetation; methods of propagation / planting of grasses and trees in silvi-pastoral system; fertilizer application in strip and silvi - pastoral systems; after-care of plantation; estimation of protein content in loppings of important fodder trees; estimation of calorie value of wood of important fuel trees; estimation of total biomass and fuel wood; economics of agro-forestry; visit to important agro-forestry research stations.

References

1. Chatterjee, B.N and Das, P.K. (1989). *Forage Crop Production. Principles and Practices*. Oxford and IBH Publication.
2. Dabadghao, P.M and Shankaranarayan, K.A. (1973). *The Grass Cover in India*. ICAR.
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21AG3012 PRINCIPLES AND PRACTICES OF ORGANIC FARMING

Credits: 3 (2+1)

Course Objectives:

To impart the knowledge on

1. The concept of organic farming.
2. The agronomic practices and farming techniques under organic farming.
3. The aspects related to legislation, inspection, certification, and marketing of organic produce.

Course Outcomes:

On completion of this course, the student will be able to:

1. Remember the concepts of organic farming including its relevance to Indian and global agriculture scenarios.
2. Understand the crop management practices and technologies for organic crop production.
3. Derive insights on soil fertility, nutrient cycle and soil biota.
4. Compare the organic crop production with inorganic crop production.
5. Apply the knowledge of standards and certification process in organic production.
6. Analyze different marketing strategies of organic farm products.

Theory

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry; organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers; farming systems, crop rotations, multiple and relay cropping systems, inter cropping in relation to maintenance of soil productivity; control of weeds, diseases and insect pest management, biological agents, pheromones, bio-pesticides; socio-economic impacts; marketing and export potential: inspection, certification, labelling and accreditation procedures; organic farming and national economy.

Practical

Aerobic and anaerobic methods of making compost; Making of vermin compost; Identification and nursery raising of important agro-forestry trees and trees for shelter belts; Efficient use of bio-fertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures infield; Visit to an

organic farm; Quality standards, inspection, certification and labelling and accreditation procedures for farm produce from organic farms.

References

1. Ananthakrishnan, T.N. (Eds.). (1992). *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford and IBH Publication.
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21AG3015 CURRENT TRENDS IN AGRONOMY

Credits: 3(3+0)

Course Objectives:

To impart knowledge on

4. The recent advances in agricultural production
5. The factors affecting crop production and yield
6. The emerging and modern crop production technologies

Course Outcomes:

On completion of this course, students will be able to

1. Learn and understand about new developments and innovations in agronomy
2. Familiarize with the advanced crop production techniques and system approaches, different management practices and their optimization
3. Acquire knowledge on the recent trends in organic agriculture and procedures for organic certification
4. Understand the various resource management approaches used in conservation agriculture.
5. Gain knowledge on seed production techniques and certification procedures
6. Acquire knowledge on recent technological applications like GIS, GPS, and remote sensing in crop management

Theory

Agro-physiological basis of variation in yield, recent advances in soil-plant-water relationship. Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures. Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy. GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc. Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

References

1. Agarwal, R.L. (1995). *Seed Technology*. Oxford & IBH Publications.
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3. Govardhan, V. (2000). *Remote Sensing and Water Management in Command Areas Agroecological Prospectives*. IBDC Publications.
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21AG3016 CROP ECOLOGY

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Different agricultural systems.
2. Different types of agro-ecological regions in crop production.
3. Adaptation of crops to different agro-climatic conditions.

Course Outcomes:

On completion of this course, students will be able to

1. Gain insights on the characteristics of crop ecosystem.
2. Identify the roles of ecological factors in crop production.
3. Understand the composition and functions of the ecosystem, with emphasis on population growth and regulation, and evolutionary strategies in plant communities.
4. Identify the major ecological zones based on rainfall distribution, vegetation features, agricultural activities and crop distribution.
5. Develop a holistic knowledge on sustainable management practices for sound farming ecosystem.
6. Recommend measures for mitigating environmental resistance (adverse crop environment) for enhanced crop productivity and yields.

Theory

Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply. Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept. Physiological response of crop plants to light, temperature, CO₂, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production. Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production. Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

References

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2. Chadha, K.L and Swaminathan, M.S. (2006). *Environment and Agriculture*. Malhotra Publications.
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11. Taiz, L and Zeiger, E. (1992). *Plant Physiology*. Benjamin/Cummings Publications.

21AG3017 IRRIGATION MANAGEMENT

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Water resources of the country and state
2. Soil-water-plant relationships
3. Advanced methods of irrigation in modern crop production

Course Outcomes:

On completion of this course, students will be able to

1. Understand the role of water in relation to metabolic and physiological functions of plants
2. Acquire knowledge on advanced strategies for irrigation management practices
3. Gain in-depth understanding about the water requirement of modern crop production systems
4. Evaluate the water quality parameters and management measures
5. Explain the techniques of efficient water use
6. Utilize the knowledge for the command area development

Theory

Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth. Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity. Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops. Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management. Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies. Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practical

Determination of water infiltration characteristics and water holding capacity of soil profiles. Moisture extraction pattern of crops. Consumptive use, water requirement of a given cropping pattern for optimum/ variable productivity. Crop planning at the farm and project level. Agronomic evaluation of irrigation projects, case studies.

References

1. Doneen, L.D and Westcot, D.W. (1988). *Irrigation Practice and Water Management*. Oxford & IBH Publications.
2. Michael, A.M. (1978). *Irrigation Theory and Practice*. Vikas Publications.
3. Mishra, R.R and Ahmad, M. (1987). *Manual on Irrigation and Agronomy*. Oxford & IBH Publications.
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21AG3018 ADVANCES IN WEED MANAGEMENT

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. The weeds in different ecosystems and their impact on modern crop production.
2. Herbicides and their application in integrated weed management.
3. The advanced methods of weed management techniques in modern crop production.

Course Outcomes:

On completion of this course, students will be able to

1. Identify the different types of weeds and their ecosystem.
2. Understand the weed biology.
3. Apply the knowledge about herbicides and their effects on modern crop production.
4. Identify the compatibility of different herbicide groups and with different agrochemicals.
5. Apply the advanced biotechnological tools and concepts in weed management
6. Evaluate various bioassay and other herbicide residue assessment techniques.

Theory

Crop-weed competition in different cropping situations; changes in weed flora, various causes and effects. Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them. Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants. Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides. Development of transgenic herbicide resistant crops; herbicide development, registration procedures. Relationship of herbicides with tillage, fertilizer and irrigation; bio-herbicides, allelochemical herbicide bioassays.

References

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6. Ross, M.A and Carola Lembi, A. (1999). *Applied Weed Science*. 2nd Ed. Prentice Hall.
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8. Zimdahl, R.L. (1999). *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

21AG3019 INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. Various enterprises under different agro climatic conditions for sustainable agriculture.
2. Improved agronomic practices for different farming systems to improve their productivity.
3. Sustainable agriculture practices.

Course Outcomes:

On completion of this course, students will be able to

1. Understand about the concept of farming system and sustainable agriculture.
2. Understand the mechanism of components in farming system.
3. Develop different simulation models for intercropping.
4. Plan and prepare different farming system models.
5. Evaluate different farming systems for sustainable agriculture.
6. Apply the knowledge of sustainable crop production in effectively guiding farmers.

Theory

Farming systems definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply and enterprises. Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management. Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping. Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems. New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

References

1. Ananthakrishnan, T.N. (Eds.). (1992). *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH Publications.
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21AG3020 SOIL CONSERVATION AND WATERSHED MANAGEMENT

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Different soil moisture conservation technologies for enhancing the agricultural productivity
2. Watershed management through a holistic approach.
3. Adaptation and mitigation strategies, crop planning and crop management techniques under various soil conditions and moisture availabilities.

Course Outcomes:**After completion of this course, the student will be able to**

1. Understand the concepts of soil erosion and soil conservation
2. Learn about implementation of watershed models
3. Develop drainage systems in agricultural lands
4. Apply the knowledge of different water conservation methods and effective ways of water utilization through watershed management
5. Formulate contingent water planning for aberrant weather conditions
6. Develop cropping systems for watershed areas

Theory

Soil erosion definition, nature and extent of erosion; types of erosion, factors affecting erosion. Soil conservation definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts. Watershed management definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas. Land use capability classification, alternate land use systems; agro-forestry; ley farming; jhum management - basic concepts, socio-ethnic aspects, its layout. Drainage considerations and agronomic management; rehabilitation of abandoned jhum lands and measures to prevent soil erosion.

Practical

Study of different types of erosion. Field studies of different soil conservation measures. Run-off and soil loss measurements. Laying out run-off plot and deciding treatments. Identification of different grasses and trees for soil conservation. Visit to a soil conservation research centre, demonstration and training centre.

References

1. Arakeri, H.R and Roy, D. (1984). *Principles of Soil Conservation and Water Management*. Oxford & IBH Publications.
2. Dhruvanarayana, V.V. (1993). *Soil and Water Conservation Research in India*. ICAR.
3. FAO. (2004). *Soil and Water Conservation in Semi-Arid Areas*. Soils Bull., Paper 57.
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21AG3021 STRESS CROP PRODUCTION**Credits: 3(2+1)****Course Objectives:****To impart knowledge on**

1. Various types of stresses in crop production
2. Strategies to overcome the stresses caused during crop production.
3. Various environmental pollutions affecting crop production and its remediation measures.

Course Outcomes:**On completion of this course, students will be able to**

1. Understand crop production techniques and crop growth in relation to stressful environment
2. Gain insights on the impact of various crop stresses like low temperature stress, heat stress, water deficit stress, flooding stress, salt stress and stress due to mechanical impedance of soil, on crop growth and yield
3. Recognize and identify effective ways to overcome the environmental stresses affecting crop growth and yield
4. Discuss the ways for effective utilization of farm resources, and crop management under adverse stressful environment conditions
5. Manage environmental pollution, their effect on crop growth and the quality of produce
6. Guide farmers on various stress factors affecting crop production, to overcome yield losses and crop failures

Theory

Stress and strain terminology; nature and stress injury and resistance; causes of stress. Low temperature stress freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress through, soil and crop manipulations. High temperature or heat stress

meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations. Water deficit stress meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations. Excess water or flooding stress meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations. Salt stress meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations. Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance. Environmental pollution air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

Practical

Determination of electrical conductivity of plant cell sap. Determination of osmotic potential and tissue water potential. Measurement of transpiration rate. Measurement of stomatal frequency. Growing of plants in sand culture under salt stress for biochemical and physiological studies. Studies on effect of osmotic and ionic stress on seed germination and seedling growth. Measurement of low temperature injury under field conditions.

References

1. Baker, F.W.G. (1989). *Drought Resistance in Cereals*. Oxon Publications. UK.
2. Gupta U.S. (Ed.). (1988). *Physiological Aspects of Dryland Farming*. Oxford & IBH Publications.
3. Kramer, P.J. (1983). *Water Relations of Plants*. Academic Press.
4. Levitt, J. (1980). *Response of Plants to Environmental Stresses*. Vols. I, II. Academic Press.
5. Mavi, H.S. (1978). *Introduction to Agro-meteorology*. Oxford & IBH Publications.
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11. Virmani, S.M., Katyal, J.C., Eswaran, H and Abrol, I.P. (1994). *Stressed Ecosystem and Sustainable Agriculture*. Oxford & IBH Publications.

21AG3025 PRINCIPLES OF GENETICS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Understanding the basic concepts of genetics.
2. Developing skills to solve analytical and quantitative problems in genetics.
3. Exploring the classical to molecular genetics.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genetic interactions and central dogma of life.
2. Analyze the advanced techniques in gene isolation, synthesis and cloning.
3. Explore the tools used in genomics, transcriptomics, proteomics and epigenetics.
4. Differentiate quantitative and qualitative genetics.
5. Understand the concept of gene silencing, DNA restriction and sequencing techniques.
6. Recognize the polymorphisms in DNA and proteins.

Theory

Beginning of Genetics; Cell Structure and Cell Division, Early concepts of inheritance, Mendel's laws, Discussion on Mendel's paper, Chromosomal Theory of Inheritance. Multiple alleles, Gene interactions, Sex determination, differentiation and sex linkage, sex-influenced and sex-limited traits, link detection, estimation, Recombination and genetic mapping in eukaryotes, somatic cell genetics, extra-chromosomal inheritance. Population, Mendelian population, Random-mating population, frequencies of genes and genotypes, causes of change, Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes, Nature, Structure and replication of the genetic material, Organization of DNA in chromosomes, Genetic code, Protein Biosynthesis. Genetic fine structure analysis, Allelic complementation, split genes, Transposable genetic elements, overlapping genes, pseudo genes, oncogenes, gene families and clusters. Regulation of gene activity in prokaryotes, molecular mechanisms of mutation, repair and suppression, bacterial plasmids, insertion (IS) and transposable (Tn) elements, molecular

chaperons and gene expression, Gene regulation in eukaryotes, RNA editing. Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR-based cloning, positional cloning, nucleic acid hybridization and immune-chemical detection, DNA sequencing, DNA restriction, modification, Anti-sense-RNA and ribozymes, Micro-RNA's (miRNA's). Genomics and Proteomics, Functional and pharmacogenomics, metagenomics. Methods of studying polymorphism at biochemical and DNA level, transgenic bacteria and bioethics, gene silencing, genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic Disorders and Behavioral genetics.

Practical

Laboratory exercises in probability and chi-square, demonstration of genetic principles using laboratory organisms, chromosome mapping using three point test cross, tetrad analysis, induction and detection of mutations, through genetic tests, DNA extraction and PCR amplification-electrophoresis-basic principles and running of amplified DNA, extraction of proteins and isozymes, use of agrobacterium mediated method and biolistic gun, practical demonstrations, detection of transgenes in the exposed plant material, visit to transgenic glass house and learning the practical considerations.

References

1. Gardner, E.J and Snustad, D.P. (1991). *Principles of Genetics*. John Wiley & Sons.
2. Klug, W.S and Cummings, M.R. (2003). *Concepts of Genetics*, Peterson Edu. Lewin B. Genes IX. Jones & Bartlett Publishers.
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6. Brown, T. A. (2012). *Introduction to genetics: a molecular approach*. Garland Science.
7. Uppal, S., Yadav, R., Subhadra and Saharan, R.P. (2005). *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU, Hisar.

21AG3026 PRINCIPLES OF CYTOGENETICS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Structure and functions of chromosomes.
2. Chromosome mapping and cytology.
3. Polyploidy and its aspects in crop evolution.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the karyotyping and banding techniques in chromosome.
2. Know the evolution of crops and role of polyploidy in crop improvement.
3. Comprehend the alien addition and substitution lines.
4. Identify the genetic hindrances in hybridization.
5. Manipulate the chromosomes for synthesis of improved crop species.
6. Generate mapping populations to initiate plant-breeding research.

Theory

Architecture of chromosomes in prokaryotes and eukaryotes, chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere, artificial chromosome construction and its uses, special types of chromosomes. Chromosomal theory of inheritance, cell cycle and cell division, mitosis and meiosis, differences significance and deviations, synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over, recombination models, cytological basis, variation in chromosome structure, evolutionary significance, introduction to techniques for karyotyping, chromosome banding and painting-*in-situ* hybridization and various applications.

Structural and Numerical variations of chromosomes and their implications, symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids, utilization of aneuploids in gene location, variation in chromosome behavior, somatic segregation and chimeras, endomitosis and somatic reduction, Evolutionary significance of chromosomal aberrations, balanced lethals and chromosome complexes. Inter-variety chromosome substitutions, Polyploidy and role of polyploids in crop breeding, evolutionary advantages of autopolyploids vs allopolyploids, role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks, transfer, Alien-addition and substitution lines, creation and utilization, apomixis, evolutionary and genetic problems in crops with apomixes. Reversion of autopolyploids to diploids, genome mapping in polyploids, interspecific hybridization and allopolyploids, synthesis of new crops (wheat, triticale and brassica), hybrids between species with same chromosome number, gene transfer using amphidiploids, Bridge species. Fertilization barriers in crop plants at pre-and post-fertilization

levels, In-vitro techniques to overcome the fertilization barriers in crops, chromosome manipulations in wide hybridization, case studies, production and use of haploids, di-haploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc., Microscopy: various types of microscopes, observing sections of specimen using electron microscope, preparing specimen for observation, fixative preparation and fixing specimen using electron microscope, preparing specimen for observation, fixative preparation and fixing specimen for light microscopy studies in cereals, studies on the course of mitosis in wheat, pearl millet, studies on the course of mitosis in onion and Aloe vera, studies on the course of meiosis in cereals, millets, pulses, studies on the course of meiosis in oilseeds, forage crops, using micrometers and studying the pollen size in various crops, various methods of staining and preparation of temporary and permanent slides, pollen germination *in vivo* and *in-vitro*, microtomy, Agents employed for the induction of various ploidy levels, solution preparation and application at seed, seedling level, identification of polyploids in different crops, induction and identification of haploids, anther culture and ovule culture, morphological observations on synthesized autopolyploids, observations on C-mitosis, learning on the dynamics of spindle fiber assembly, morphological observations on allopolyploids, morphological observations on aneuploids. Cytogenetic analysis of interspecific and intergeneric crosses, maintenance of cytogenetic stocks and their importance in crop breeding, various ploidy levels due to somoclonal variation, polyploidy in ornamental crops, fluorescent *in-situ* hybridization (FISH), Genome *in situ* Hybridization (GISH).

References

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2. Charles, B. (1993). *Discussions in Cytogenetics*. Prentice Hall Publishers.
3. Darlington, C. D and La Cour, L.F. (1969). *The Handling of Chromosomes*. George Allen and Unwind Ltd.
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21AG3027 PRINCIPLES OF PLANT BREEDING

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Skills to reinforce the goals of plant breeding
2. Different modes of reproduction in crops
3. Identify the genetic consequences and breeding methods in crop improvement

Course Outcomes:

On completion of this course, students will be able to

1. Ascertain the breeding methods of self, cross and often cross pollinated crops
2. Understand the influence of transgressive and mutation breeding
3. Explore the fundamentals of stress breeding
4. Apprehend the essentials of maintenance breeding and varietal release procedures
5. Identify the appropriate tools for hybridization Programs
6. Select the best combiners for varietal and hybrid breeding

Theory

History of Plant Breeding (Pre and Post Mendelian era), Objectives of plant breeding, characteristics improved by plant breeding, patterns of evolution in crop plants, Centers of Origin-biodiversity and its significance. Genetic basis of breeding self and cross pollinated crops including mating systems and response to selection, nature of variability, components of variation, heritability and genetic advance, genotype, environment interaction, General and Specific combining ability, types of gene actions and implications in plant breeding, plant introduction and

role of plant genetic resources in plant breeding. Self-incompatibility and male sterility in crop plants and their commercial exploitation. Pure line theory, Pure line selection and mass selection methods, line breeding, pedigree, bulk, backcross, single seed descent and multiline method, Population breeding in self-pollinated crops (diallel selective mating approach). Breeding methods in cross pollinated crops, population breeding mass selection and ear to row methods, S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites, hybrid breeding, genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance, seed production of hybrid and their parent varieties/inbreds. Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection. Self-incompatibility and male sterility in crop plants and their commercial exploitation, concept of plant ideotype and its role in crop improvement, transgressive breeding. Special breeding techniques, mutation breeding, breeding for biotic and abiotic stresses. Cultivar development, testing, release and notification, maintenance breeding, Participatory Plant breeding, plant breeder's rights and regulations for plant variety protection and farmer's rights.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques, selection methods in segregating populations and evaluation of breeding material, analysis of variance (ANOVA), Estimation of heritability and genetic advance, maintenance of experimental records, learning techniques in hybrid seed production using male-sterility in field crops.

References

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21AG3028 PRINCIPLES OF QUANTITATIVE GENETICS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Theoretical and computational skills for estimating the components of variation.
2. Mating designs in plant breeding.
3. Gene action, scales and gene effects.

Course Outcomes:

On completion of this course, students will be able to

1. Decide suitable breeding procedures for trait specific breeding programs.
2. Understand the gene actions and selection indices for identifying suitable parents.
3. Compute the designs of experiments and analyses involved in breeding programs.
4. Interpret the results of mating designs and their implications in plant breeding.
5. Generate mapping populations for QTL analysis.
6. Understand the effect of G x E interactions and stability models in crop improvement.

Theory

Mendelian traits vs polygenic traits, nature of quantitative traits and its inheritance, multiple factor hypothesis, analysis of continuous variation, variations associated with polygenic traits, phenotypic, genotypic and environmental, non-allelic interactions, nature of gene action, additive, dominance, epistatic and linkage effects. Principles of Analysis of Variance (ANOVA), Expected variance components, random and fixed models, MANOVA, biplot analysis, Comparison of means and variances for significance. Designs for plant breeding experiments, principles and applications, Genetic diversity analysis, metroglyph, cluster and D2 analyses, Association analysis, phenotypic and genotypic correlations, path analysis and parent progeny, regression analyses, Discriminant function and principal component analyses, selection indices, selection of parents, simultaneous selection models concepts of selection, heritability and genetic advance. Generation mean analysis, Mating systems, Diallel partial diallel, line x tester analysis, NCD's and TTC's, Concepts of combining ability and gene action, Analysis of genotype x environment interaction, adaptability and stability, models for G x E

analysis and stability parameters, AMMI analysis, principles and interpretation, QTL mapping, strategies for QTL mapping, desired populations for QTL mapping, statistical methods in QTL mapping, QTL mapping genetic analyses, Marker assisted selection (MAS), Approaches to apply MAS in plant breeding, selection based on marker, simultaneous selection, based on marker and phenotype, factors influencing MAS.

Practical

Problems on multiple factor inheritance, Partitioning of variance, Estimation of Heritability and Genetic Advance, Covariance analysis, Metroglyph analysis, D2 analysis, Grouping of clusters and interpretation, cluster analysis, construction of cluster diagrams and dendrograms, interpretation, Correlation analysis, Path analysis, Parent Progeny, regression analysis, Diallel analysis, Griffing's methods I and II, Diallel analysis: Hayman's graphical approach, Diallel analysis, interpretation of results, NCD and their interpretations, Line x tester analysis and interpretation of results, Estimation of heterosis, standard, mid-parental and better-parental heterosis, estimation of inbreeding depression, Generation mean analysis, Analytical part and Interpretation, Estimation of different types of gene actions. Partitioning of phenotypic variance and Co-variance into components due to genotypes, environment and genotype x environment interactions, Construction of saturated linkage maps and QTL mapping, Strategies for QTL mapping, statistical methods in QTL mapping, phenotype and marker linkage studies. Working out efficiency of selection methods in different populations and interpretations, bi-parental mating, triallel analysis, quadriallel analysis and triple test cross, use of software in analysis and result interpretation. Advanced biometrical models for combining ability analysis, models in stability analysis, Additive Main Effect and Multiplicative Interaction (AMMI) model, principal component analysis model, additive and multiplicative model-shifted, multiplicative model, analysis and selection of genotypes, methods and steps to select the best model, selection systems, biplots and mapping genotypes.

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21AG3029 MUTAGENESIS AND MUTATION BREEDING

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Types of mutagens and their effect on creating variability in crop plants.
2. Development of crop varieties by mutation breeding.
3. Risks and perspectives associated with mutation breeding.

Course Outcomes:

On completion of this course, students will be able to

1. Inculcate the use of mutagens for inducing the variability in crops
2. Understand the varying advanced mutational approaches involving TILLING and allele mining
3. Handle the segregating population in mutation breeding
4. Identify the dose concentration for acquiring the desired phenotype
5. Generate SNPs by using mutagen
6. Detect the effects of mutations in quantitatively inherited traits

Theory

Mutation and its history, Nature and Classification of mutations, spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations, Detection of mutations in lower and higher organisms and paramutations. Mutagenic agents, physical radiations: Radiations types and sources, Ionizing and non-ionizing radiations viz., X-rays, Gamma rays and Beta particles, protons, neutrons and UV rays, Radiobiology, mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects, RBE and LET relationships. Effects of mutations on DNA, repair mechanisms operating at

DNA, chromosome, cell and organism level to counteract the mutation effects, dosimetry, objects and methods of treatment, Factors influencing mutation, dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects, Radiation sensitivity and modifying factors, external and internal sources, oxygen water content, temperature and nuclear volume. Chemical mutagens, classification, base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens, their properties and mode of action, dose determination and factors influencing chemical mutagenesis, treatment methods using physical and chemical mutagens, combination treatments, other causes of mutation, direct and indirect action, comparative evaluation of physical and chemical mutagens.

Observing mutagen effects in M_1 generation, plant injury, lethality, sterility, chimeras etc., observing mutagen effects in M_2 generation, estimation of mutagenic efficiency and effectiveness spectrum of chlorophyll and viable mutations, mutations in traits with continuous variation. Factors influencing the mutant spectrum, genotype, type of mutagen and dose, pleiotropy and linkage etc., Individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation, Comparative evaluation of physical and chemical mutagens for creation of variability in the same Species-Case Studies. Use of mutagens in creating oligogenic, and polygenic variations-case studies, in-vitro mutagenesis, callus and pollen irradiation, handling of segregating generations and selection procedures, validation of mutants, mutation breeding for various traits (disease resistance, insect resistance, quality improvement etc.,) in different crops. Procedures for micro mutation breeding, polygenic mutations, achievements of mutation breeding, varieties released across the world, problems associated with mutation breeding. Use of mutagens in genomics, allele mining, tilling.

Practical

Learning the precautions on handling of mutagens, Dosimetry, Studies of different mutagenic agents, physical mutagens, studies of different mutagenic agents, chemical mutagens, learning on radioactivity, production of source and isotopes at BRIT, Trombay, Learning about gamma chamber, radiation hazards, monitoring. Safety regulations and safe transportations, visit to radio isotope laboratory, learning on safe disposal of radio isotopes, hazards due to chemical mutagens, treating the plant propagules at different doses of physical and chemical mutagens, learning combined mutagenic treatments, raising the crop for observation, mutagenic effectiveness and efficiency, calculating the same from earlier literature, study of M_1 generation, parameters to be observed, study of M_2 generation, Parameters to be observed, mutation breeding in cereals and pulses, achievements made and an analysis, mutation breeding in oilseeds and cotton achievements and opportunities. mutation breeding in forage crops and vegetative propagated crops, Procedure for detection of mutations for polygenic traits in M_2 and M_3 generations.

References

1. Alper, T. (1979). *Cellular Radiobiology*. Cambridge Univ Press London Publications.
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3. Cotton, R.G.H., Edkin, E and Forrest, S. (2000). *Mutation Detection: A Practical Approach*. Oxford Univ. Press Publications.
4. International Atomic Energy Agency. (1970). *Manual on Mutation Breeding*. International Atomic Energy Vienna, Italy.
5. Singh, B.D. (2003). *Genetics*. Kalyani Publishers.
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21AG3030 POPULATION GENETICS

Credits: 2 (1+1)

Course Objectives:

To impart knowledge on

1. The frequency of genes and genotypes in a population
2. Population structure, properties and criterions of Hardy-Weinberg equilibrium
3. Effects of inbreeding and migration of new species in a population

Course Outcomes:

On completion of this course, students will be able to

1. Analyze the population equilibrium
2. Determine the frequency distribution of traits in each generation
3. Evaluate the linkage and fitness of a population
4. Apply the Hardy-Weinberg law to identify mating frequencies
5. Predict the genetic erosion in a given population
6. Estimate the deviations in the hereditary traits which were created by GxE interactions

Theory

Population, Properties of Population, Mendelian Population, Genetic constitution of a population through time, space, age structure etc. Mating systems, Random-mating population, Frequencies of genes and genotypes, Causes

of change, population size, differences in fertility and viability, migration and mutation. Hardy-Weinberg equilibrium, Hardy –Weinberg Equilibrium, Hardy-Weinberg law, Proof, Applications of the Hardy-Weinberg Law, Test of Hardy-Weinberg equilibrium, mating frequencies, non-dominance, Codominance, Synder's ratio, importance and its effect over random mating in succeeding generations. Multiple alleles, more than one locus, Sex linked genes, use of gene and genotypic frequencies, evaluation in field population level, Interpretations, Changes of gene frequency, migration, mutation, recurrent and non-recurrent, selection, balance between selection and mutation, selection favoring heterozygotes, over dominance for fitness. Non- random mating, selfing, inbreeding coefficient, panmictic index, sib mating, Assortative mating and dissortative mating, Pedigree populations and close inbreeding, Estimation of selection, Estimation of disequilibrium, estimation of linkage, correlation between relatives and estimation of F, Effect of inbreeding and sibbing in cross pollinated crops. Gene Substitution and average effects, Breeding Value, Genetic drift, Genetic slippage, Co-adapted gene complexes, homeostasis, Adaptive organization of gene pools, polymorphism, balanced and non-balanced polymorphisms, heterozygous advantage, Survival of recessive and deleterious alleles in populations.

Practical

Genetic exercise on probability; Estimation of gene frequencies; Exercises on factors affecting gene frequencies; Estimation of average affect of gene substitution and breeding value; Exercises on inbreeding and linkage disequilibrium- Cavalli's joint scaling test; Exercises of different mating designs; Estimation of different population parameters from experimental data; Measurement of genotype-environmental interaction; Genetic divergence.

References

1. Chawla, V and Yadava, R.K. (2006). *Principles of Population Genetics-A Practical Manual*. Dept. of Genetics, CCSHAU, Hisar.
2. Falconer, D.S and Mackay, J. (1996). *Introduction to Quantitative Genetics*. Wiley & Sons Publications.
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6. Sorrens, D and Daniel, G. (2007). *Methods in Quantitative Genetics*. Series: Statistics for Biology and Health Likelihood
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21AG3031 HETEROSIS BREEDING

Credits: 2 (1+1)

Course Objectives:

To impart knowledge on

1. Mechanisms of heterosis.
2. Exploitation of heterosis.
3. Exploring the molecular basis of heterosis.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genetic interactions of alleles as the basis for heterosis.
2. Analyze the advanced techniques in prediction of heterosis.
3. Explore the tools for exploitation of heterosis.
4. Differentiate the types of heterosis at field level.
5. Understand the procedures to fix the heterosis.
6. Exploit the heterosis for commercial purpose.

Theory

Historical aspect of heterosis - Nomenclature and definitions of heterosis – Heterosis in natural population and inbred population; Evolutionary aspects. Genetic consequences of selfing and crossing in self cross-pollinated and asexually propagated crops. Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; Evolutionary concepts of heterosis. Prediction of heterosis from various Crosses-Inbreeding depression, frequency of inbreeding and residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis case studies. Relationship between genetic distance and expression of heterosis.

Divergence and genetic distance analyses morphological and molecular genetic distance in predicting heterosis, development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis. Types of male sterility and use in heterosis breeding; maintenance, transfer and restoration of different types of male sterility; use of self-incompatibility in development of hybrids; hybrid seed production system: 3-line, 2-line and 1-line system; development of inbreds and parental lines-A, B and R lines – functional male sterility; Commercial exploitation of heterosis-maintenance breeding of parental lines in hybrids. Fixation of

heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; male sterile line creation and diversification in self-pollinated, cross pollinated and asexually propagated crops; problems and prospects; apomixis in fixing heterosis-concept of single line hybrid. Organellar heterosis and complementation-creation of male sterility through genetic engineering and its exploitation in heterosis. Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical

Selection in dices and selection differential – Calculations and interpretations-Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming the Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops- Estimation from the various models for heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

References

1. *Proceedings of Genetics and Exploitation of Heterosis in Crops*. (1998) – An International Symposium CIMMYT.
2. Akin, E. (1979). *The Geometry of Population Genetics*. Springer Publications.
3. Verlag and Ben Hui Lin. (1998). *Statistical Genomics – Linkage, Mapping and QTL Analysis*. CRC Press Publications.
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9. Srivastava, S and Tyagi, R. (1997). *Selected Problems in Genetics*. Vols. I, II. Anmol Publications.

21AG3032 CELL BIOLOGY AND MOLECULAR GENETICS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Structural components of cell.
2. Basic functions of cell and their organelles.
3. Understanding the classical to molecular basis for heredity.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic functioning of cell.
2. Analyze the cell division and its impacts in cell growth.
3. Explore the molecular structure of DNA, RNA and Proteins.
4. Understand the signaling pathways in plants.
5. Observe the basics of gene amplification techniques.
6. Recognize the protein-protein interactions for cell aging.

Theory

Ultra structure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular organelles – nucleus, plastids - chloro/ chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes. Bioenergetics; Ultra structure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus-Structure and chemical composition; Cell division and physiology of cell division. Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation– Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors. Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein- protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

Practical

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method; Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal

population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numerical: problems and assignments.

References

1. Bruce, A. (2004). *Essential Cell Biology*. Garland.
2. Karp, G. (2004). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley Publications.
3. Klug, W and Cummings, M.R. (2003). *Concepts of Genetics*. Foreman & Co. Publishing House, Scotland.
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21AG3033 BIOTECHNOLOGY FOR CROP IMPROVEMENT

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Practical applications of advanced biotechnological tools.
2. Developing skills to exploit the usefulness of biotechnological tools for crop improvement.
3. The basic principles of marker assisted selection.

Course Outcomes:

On completion of this course, students will be able to

1. Do micropropagation in crop plants.
2. Understand the quantification and quality assessment of plant genomic DNA.
3. Practice the vector based cloning procedures.
4. Apply their knowledge on mapping and tagging of agronomically important traits.
5. Transfer foreign genes into plants through rapid introgression methods .
6. Gain knowledge on legal and ethical views about GMOs.

Theory

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation. Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F₂s, backcrosses, RILs, NILs and DH).

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Marker-assisted selection and molecular breeding; Genomics and Geno-informatics for crop improvement; Integrating functional genomics information on agronomically / economically important traits in plant breeding; Marker-assisted back cross breeding for rapid introgression, Generation of EDVs.

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. Biotechnology applications in male sterility/hybrid breeding, molecular farming.

MOs and related issues (risk and regulations); GMO; International regulations, bio-safety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual Property Rights. Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement Programs.

Practical

Requirements for plant tissue culture Laboratory-Techniques in plant tissue Culture-Media components and media preparation- Aseptic manipulation of various explants; observations on the contaminants occurring in media – Interpretations-Inoculation of explants; Callus induction and plant regeneration – Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures- Visit to commercial micro propagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis

of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

References

1. Chopra, V.L and Nasim, A. (1990). *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.
2. Gupta, P.K. (1997). *Elements of Biotechnology*. Rastogi Publishing Company.
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21AG3034 BREEDING FOR QUALITY TRAITS

Credits: 2 (1+1)

Course Objectives:

To impart knowledge on

1. The inheritance pattern of quality traits.
2. Molecular basis of quality traits in different crop species.
3. Understand the concept of Nutrigenomics.

Course Outcomes:

On completion of this course, students will be able to

1. Provide an insight in recent advances in improvement of quality traits.
2. Understand the breeding methods to increase the physiological efficiency of crops.
3. Apply their knowledge on developmental biochemistry of carbohydrate and Proteins.
4. Develop GMOs with improved quality.
5. Recognize the genetic engineering tools for quality improvement.
6. Evaluate the mapping populations using MAS procedures.

Theory

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors- nutritional improvement. A human perspective – breeding for grain quality parameters in rice and its analysis-golden rice and aromatic rice–breeding strategies, achievements and application in Indian context - molecular basis of quality traits and their manipulation in rice - post harvest manipulation for quality improvement. Breeding for baking qualities in wheat; characters to be considered and breeding strategies - molecular and cytogenetic manipulation for quality improvement in wheat - breeding for quality improvement in barley and oats. Breeding for quality improvement in sorghum and pearl millet; quality protein maize – concept and breeding strategies – breeding for quality improvement in fore crops - genetic resource management for sustaining nutritive quality in crops. Breeding for quality in pulses - breeding for quality in groundnut, sesame, sunflower and minor oilseeds–molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton. Genetic engineering protocols for quality improvement – Achievements made - Value addition in crops; Classification and importance – Nutritional genomics and Second-generation transgenics.

Practical

Grain quality evaluation in rice; correlating ageing and quality improvement in rice-quality analysis in millets; estimation of anti-nutritional factors like tannins in different varieties / hybrids; a comparison - quality parameters evaluation in wheat; quality parameters evaluation in pulses – quality parameters evaluation in oilseeds; value addition in crop plants; post-harvest processing of major field crops; quality improvement in crops through tissue culture techniques; evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures.

References

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2. Chopra, V.L. (1997). *Plant Breeding*. Oxford & IBH Publishing Company.
3. FAO. (2001). *Speciality Rice of the World- Breeding, Production and Marketing*. Oxford & IBH Publications.
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5. Hay, R.K. (2006). *Physiology of Crop Yield*. 2nd Ed. Black Well Publishing Corporation.
6. Nigam, J. (1996). *Genetic Improvement of Oilseed Crops*. Oxford & IBH Publishing House.
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8. Singh, R.K., Singh, U.K and Khush, G.S. (2000). *Aromatic Rice*. Oxford & IBH Publishing House.

21AG3035 GENE REGULATION AND EXPRESSION

Credits: 2 (2+0)

Course Objectives:

To impart knowledge on

1. Gene regulation.
2. Pattern formation.
3. Gene expression.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genetic and molecular basis of gene regulation.
2. Remember the mechanism of genetic control over gene expression and regulation.
3. Apply the knowledge of gene silencing in crop improvement.
4. Incorporate the knowledge in developing model plant systems.
5. Analyze the strategies for transposon cloning.
6. Understand the mechanism of trait expression in plants and microbes.

Theory

Introduction: gene regulation - purpose; process and mechanisms in prokaryotes and eukaryotes; levels of gene controls. Coordinated genetic regulation-examples – anthocyanin and gene families and maize; genetic and molecular basis depending on tissue specificity. Gene expression-transposons in plant gene expression, cloning-transposon tagging; light regulated gene expression-model systems in *Arabidopsis* and maize; para mutations and imprinting of genes and genomes. Transgene expression and gene silencing mechanisms; regulatory genes-horizontal and vertical homology; transformation-regulatory genes as visible markers; reporter systems to study gene expression; combinatorial gene control. Eukaryotic transcriptional control; translational and post-translational regulation; signal transduction; stress-induced gene expression; gene traps and enhancer traps.

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2. Schleif, R. (1986). *Genetics and Molecular Biology*. Addison-Wesley Publishing Corporation.
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12. Watson, J.D. (2004). *Molecular Biology of the Gene*. Pearson Edu. Publications. Co.

21AG3038 PLANT GENETIC RESOURCES AND THEIR UTILIZATION

Credits: 2(2+0)

Course objectives:

To impart knowledge on

1. Concepts of plant exploration and collection
2. Conservation practices of germplasm accessions
3. Quarantine procedures for introduced collections

Course Outcomes:

On Completion of this course, students will be able to

1. Locate the micro and mega gene centers of crop plants
2. Understand the diversity hotspots concepts
3. Apply the procedures in germplasm exchange formalities
4. Realize the importance for plant quarantine certificates
5. Recognize the plant introductions which turned into weeds
6. Analyze the intellectual property rights and their regulations

Theory

Historical perspectives and need for PGR conservation; Importance of plant genetic resources; Taxonomical classification of cultivated plants; Genepool primary, secondary and tertiary; Centres of origin and global pattern of diversity; Basic genetic resources and transgenes. Principles, strategies and practices of exploration,

collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.

Germplasm conservation- *in situ*, *ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources. PGR database management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; SeedAct, *suigeneris* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.

Journey from wild to domestication; Genetic enhancement-need for genetic enhancement; Genetic enhancement in pre-Mendelian era and 21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/traits- novel genes for quality.

Distant Hybridization Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression. Post-genomic tools for genetic enhancement of germplasm; Pre-breeding through chromosome manipulation; Application of biotechnology for Genetic Enhancement - Achievements. Utilization of genetic resources, concept of core and mini-core collections, genetic enhancement /Pre-breeding for crop improvement including hybrid development.

References

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21AG3039 ADVANCES IN QUANTITATIVE GENETICS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Theoretical and computation skills for estimating the components of variation
2. Evaluating the mating designs in plant breeding
3. Interpreting the gene action, scales and gene effects

Course Outcomes:

On completion of this course, students will be able to

1. Decide on identifying suitable breeding procedures for trait specific improvement
2. Interpret the gene actions and selection indices for identifying suitable parents
3. Analyze the designs of experiments involved in breeding programs
4. Interpret the results effected in mating designs and analyze their statistical parameters
5. Generate mapping populations for QTL analysis and marker assisted selection
6. Identify the marker-trait association in a population

Theory

Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes; Designs and Systems; Selection of stable genotypes. Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Principal Component Analysis. Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes.

Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance - Construction of saturated linkage maps, concept of framework map development; QTL mapping - Strategies for QTL mapping-desired populations, statistical methods; Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers -

simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Practical

Working out efficiency of selection methods in different populations and interpretation - Biparental mating – use of softwares in analysis and result interpretation - Triallel analysis– use of softwares in analysis and result interpretation - Quadriallel analysis – use of softwares in analysis and result interpretation - Triple Test Cross (TTC) – use of softwares in analysis and result interpretation - Advanced biometrical models for combining ability analysis - Selection of stable genotypes using stability analysis; Models instability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model-Principal Component Analysis model-Additive and multiplicative model- Shifted multiplicative model-Analysis and selection of genotypes – Methods and steps to select the best model – Selection systems-Biplot and mapping genotypes.Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

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6. Singh, R. K and Choudhary, B. D. (1987). *Biometrical Methods in Quantitative Genetics*. Kalyani Publishers.
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21AG3040 GENOMICS IN CROP IMPROVEMENT

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Advanced molecular techniques in genome mapping
2. Structural and functional genomics
3. Development of transgenic crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the molecular description of nuclear and organellar genomes
2. Remember the mechanism of genetic control over gene expression and regulation
3. Apply the knowledge in gene and QTL mapping
4. Incorporate the knowledge in sequencing techniques
5. Analyze the strategies for TILLING and Eco-TILLING
6. Understand the role of 'omics' in linking of the genome with phenome

Theory

Introduction to the Plant genome – Plant nuclear genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity. Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Map-based cloning of plant genes.

Regulation of Plant gene expression - Functional genomics – Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis - methods and significance – Diversity Array Technology. Genome sequencing in plants – Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics– Genome Comparison Techniques- Classical and advanced approaches.

Detection of Single Nucleotide Polymorphism; TILLING and Eco-TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies - Knock out mutant studies and high throughput phenotyping. Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical

Chromosome analysis in major field crops - Fluorescence *in situ* hybridization -Comparative genomic hybridization – Comparative analysis of plant genomes using molecular markers – Genetic map construction using molecular markers – Mapping major genes using molecular markers – QTL mapping in plants – Comparison across mapping populations – Understanding the need genetic algorithms in QTL mapping – Plant Genome

Databases – Computational tools to explore plant genome databases – Comparative genomics – Comparison of genome sequences using tools of bioinformatics- Advanced genomic technologies TILLING and Eco-TILLING – DNA Array Technology – Linking genome sequences to phenotypes Tools of transcriptomics, proteomics and metabolomics.

References

1. Baxevanis, A. Dand Ouellette, B. F. F. (2001). *Bioinformatics A Practical Guide to the Analysis of Genes and Proteins*. Wiley and Sons.
2. Brown, T.A. (2002). *Genomes*. Wiley-LISS.
3. Caetano- Anolles, Gand Gresshoff, P.M. (1998). *DNA Markers Protocols, Applications and Overviews*. Wiley-VCH.
4. Cantor, C. R and Smith, C. L. (2004). *Genomics*. Wiley and Sons, New York.
5. Galas, D.J and Mc Cormack, S.J. (2002). *Genomic Technologies Present and Future*. Calster Academic Press.
6. Jordan, B.R. (2001). *DNA Microarrays Gene Expression Applications*. Springer Verlag.
7. Liu, B.H. (1997). *Statistical Genomics Linkage, Mapping and QTL Analysis*. CRS Press.
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13. Rampal, J.B. (2001). *DNA Arrays Methods and Protocols*. Humana Press.

21AG3041 CELLULAR AND CHROMOSOMAL MANIPULATIONS IN CROP IMPROVEMENT

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Advancements in analyzing the chromosome structure
2. Chromosome manipulations
3. Genome analysis

Course Outcomes:

On completion of this course, students will be able to

1. Understand the organization of organellar and nuclear genomes
2. Remember the karyotyping procedures
3. Apply cytological techniques for crop improvement
4. Evaluate the breeding behavior in aneuploids
5. Apply different micro propagation techniques
6. Analyze various hybridization protocols for crop breeding

Theory

Organization and structure of genome – Genome size – Organization of organellar genomes – Nuclear DNA organization–Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content – C value paradox; Sequence complexity–Introns and Exons – Repetitive sequences – Role of repetitive sequence.

Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of genes/genomic segments; Distant hybridization - Role of polyploidy in crop evolution and breeding - auto and allopolyploids.

Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes deficiency method; Interchange-genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes- linked marker methods; Duplication-production and use; Inversions and location of genes; B/A chromosome translocations and gene location.

Trisomics- types, production, breeding behavior and location of genes, use of balance tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behavior and location of genes; Inter varietal substitutions - allelic and non-allelic interactions; Telocentric method of mapping. Barriers to interspecific and intergeneric hybridization – Behavior of interspecific and intergeneric crosses; Totipotency of cells–Morphogenesis *in vivo* and *in vitro* – Meristem culture – anther and pollenculture – ovule, ovary, embryo and endosperm culture – protoplast isolation and culture–protoplast fusion, Different pathways of *invitro* morphogenesis–organogenesis and somatic embryogenesis; *invitro* mutant/ somaclone selection for biotic and abiotic stresses.

References

1. Clark, M.S and Wall, W.J. (1996). *Chromosomes The Complex Code*. Chapman and Hall.
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21AG3042 ADVANCED PLANT BREEDING SYSTEMS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Computational methods for non-allelic interactions
2. Mating designs
3. Component analysis and their significance in plant breeding

Course Outcomes:

On completion of this course, students will be able to

1. Understand the evolutionary concepts of plant breeding
2. Apply the principles of plant breeding in developing breeding populations
3. Synthesize Mendelian and complex populations
4. Understand the selection principles for self- and cross-pollinated crops
5. Analyze different genetic engineering methods for developing male sterile populations
6. Generate new cyto-nuclear systems to diversify the male sterile systems

Theory

Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

Self-incompatibility and sterility – Types of Self-Incompatibility, homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility. Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self-incompatibility; Sterility male and female sterility – Types of male sterility genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic, biochemical and molecular bases.

Population formation by hybridization - Types of populations – Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement. Selection in self-fertilizing crops; Creation of genetic variability selection methods - Selection methods mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross.

Selection in cross fertilizing crops – Polycross and top cross selections, Mass and recurrent selection methods and their modifications – Mass selection grid mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) - Recurrent selection for general combining ability (GCA) – Concepts and utilization - Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding Programs - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self – incompatibility and sterility in plant breeding – case studies. Fertility restoration in male sterile lines and restorer diversification Programs. Conversion of agronomically ideal genotypes into male sterile. Concepts and breeding strategies; case studies - generating new cytonuclear interaction system for diversification of male sterile lines - Stability of male sterile lines – Environmental influence on sterility – Environmentally Induced Genic Male Sterility (EGMS) - Types of EGMS; Influence on their expression, genetic studies; Photo and thermosensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding – Apomixis and its use in heterosis breeding – Incongruity – Factors influencing in congruity - Methods to overcome incongruity mechanisms.

References

1. Agarwal, R.L. (1996). *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford and IBH.

2. Allard, R.W. (1966). *Principles of Plant Breeding*. John Wiley and Sons.
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12. Welsh, J.R. (1981). *Fundamentals of Plant Genetic and Breeding*. John Wiley.
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21AG3043 CROP EVOLUTION

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Concepts of crop evolution
2. Domestication of different crops from centers of origin
3. Ploidy level manipulations for crop improvement

Course Outcomes:

On completion of this course, students will be able to

1. Remember the center of origin for various crop species
2. Understand the process of speciation and domestication
3. Analyze the methods for exploiting the natural variation
4. Understand the concepts of crop evolution
5. Realize the historical domestication events
6. Conserve the genetic base of a crop

Theory

Origin and evolution of species; Centers of diversity/ origin, diffused centers; Time and place of domestication; Patterns of evolution and domestication- examples and Case studies. Domestication and uniformity – Characteristics of early domestication and changes – Concept of gene pools and crop evolution; Selection and Genetic drift - Consequences. Speciation and domestication – The process of speciation – Reproductive isolation barriers – Genetic differentiation during speciation – Hybridization – speciation and extinction. Exploitation of natural variation – Early attempts to increase variation – Distant hybridization and introgression – Inter - specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer into cultivated species, tools and techniques; Validation of transferred genes and their expression; Controlled introgressions.

Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; Genome organization – Transgenesis in crop evolution – Multifactorial genome – Intragenomic interaction – Intergenomic interaction – Genome introgression. Methods to study crop evolution - Contemporary methods – Based on morphological features – Cytogenetic analysis – Allozyme variations and crop evolution – DNA markers, genome analysis and comparative genomics. Evolutionary significance of polyploidy, Evolution of crop plants through ploidy manipulations; polyploids methods, use of autopolyploids; haploidy-method of production and use; allopolyploids- synthesis of new crops; - Case studies – Cereals – Pulses – Oilseeds – vegetables, Fiber crops - Plantation crops – Forage crops – Tuber crops – Medicinal Plants.

References

1. Hancock, J.F. (2004). *Plant Evolution and the Origin of Crop Species*. 2nd Ed. CABI.
2. Ladizinsky, G. (1999). *Evolution and Domestication*. Springer.
3. Miller, A. J. (2007). *Crop Plants Evolution*. John Wiley and Sons.
4. Smartt, J and Simmonds, N.W. (1995). *Evolution of Crop Plants*. Blackwell.

21AG3044 BREEDING DESIGNER CROPS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Developing physiologically efficient crops
2. Nutritional enhancement through bio fortification in crops

3. Industrial and pharma applications in plant breeding

Course Outcomes:

On completion of this course, students will be able to

1. Outline the objectives, concepts of ideotype breeding
2. Understand the methods to enhance the nutrients by biofortification
3. Develop breeding strategies for producing crops with special traits
4. Acquire the knowledge in advanced hybridization techniques
5. Apply the methods of breeding in developing pharmaceutically important crops
6. Realize the industrial applications of plant breeding

Theory

Breeding of crop ideotypes; Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds - proteins, vaccines, gums, starch and fats. Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode; Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.

Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

Breeding for special traits viz. oil, protein, vitamins, amino acids etc.; Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming. Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management

Practical

Demonstration of plant responses to stresses through recent techniques; Water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salts shock proteins.

References

1. Balint, A. (1984). *Physiological Genetics of Agricultural Crops*. AKAdemia kiado.
2. Hay, R. K. (2006). *Physiology of Crop Yield*. 2nd Ed. Blackwell.
3. Pessarakli, M. (1995). *Handbook of Plant and Crop Physiology*. Marcel Dekker.
4. Taiz, L and Zeiger, E. (2006). *Plant Physiology*. 4th Ed. Sinauer Associates.

21AG3045 ADVANCES IN BREEDING OF MAJOR FIELD CROPS

Credits: 3 (3+0)

Course Objectives:

To impart knowledge on

1. Recent advances in improvement of cereals, millets and non-cereal crops
2. Conventional breeding approaches in field crop improvement
3. Modern biotechnological tools in the improvement of major field crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand speciation and phylogenetic relationship in field crops
2. Outline the objectives, concepts, breeding methods of field crops
3. Develop breeding strategies for major field crops
4. Acquire the knowledge in advanced hybridization techniques and inbreeding methods
5. Apply methods of breeding in development of biotic and abiotic stress resistant varieties
6. Realise the achievements in improvement of field crops

Theory

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non-cereal crops like rice, wheat, maize, pearl millet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Breeding objectives in rice, wheat, maize, pearl millet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.

Breeding for value addition and resistance to abiotic and biotic stresses. Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics. National and International accomplishments in genetic improvement of major field crops and their seed production.

References

1. Chopra, V. L. (2001). *Breeding Field Crops-Theory and Practice*. Oxford and IBH.
2. Davis, D. D. (1978). *Hybrid Cotton Specific Problems and Potentials*. Adv. Agron. 30 (129-157).
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6. Rao, V. S., Singh, G and Misra, S. C. (2004). *Wheat Technologies for Warmer Areas*. Annamaya Publications.
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8. Singh, S and Singh, P. 2006. *Trends in Wheat Breeding*. Kalyani Publishers.

21AG3090 ADVANCED INSECT SYSTEMATICS

Credits: 3(1+2)

Course Objectives:

To impart knowledge on

1. Insect classification, phylogenetics, classical and molecular methods
2. Evolution of different groups of insects and International Code of Zoological Nomenclature
3. Ethics and procedure for taxonomic publications

Course Outcomes:

On completion of this course, students will be able to

1. Understanding and learning about insect classification, evolutionary history and cladistics
2. Familiarize with the International Code of Zoological Nomenclature, including appendices to ICZN- Ethics
3. Acquire knowledge on the evolution of insects
4. Understand the concept of phylocode
5. Gain Knowledge on alternative naming systems for insects
6. Acquire knowledge on molecular taxonomy and barcoding species

Theory

Detailed study of three schools of classification - numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography. Study of different views on the evolution of insects- alternative phylogenies of insects Kukulova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times. Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic Publications – small Publications of species descriptions, revisionary works, monographs, checklists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.

Practical

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, construction of taxonomic keys for the selected group. Development of descriptions, photographing, writing diagrams, and preparation of specimens for “type like” preservation. Submission of the collections made of the group. Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer Programs to develop cladograms.

References

1. CSIRO (1990). *The Insects of Australia A Text Book for Students and Researchers*. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.
2. Dakeshott, J and Whitten, M. A. (1994). *Molecular Approaches to Fundamental and Applied Entomology*. Springer-Verlag, Berlin.
3. Freeman, S and Herron, J.C. (1998). *Evolutionary Analysis*. Prentice Hall, New Delhi.
4. Hennig, W. (1960). *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.
5. Hoy, M.A. (2003). *Insect Molecular Genetics An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.
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21AG3091 ADVANCED INSECT PHYSIOLOGY

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Physiology of various secretory and excretory systems
2. Insect metamorphosis, moulting and chitin synthesis
3. Physiology of digestion, reproductive and nervous system

Course Outcomes:

On completion of this course, students will be able to

1. Understand the physiology and biochemistry of insect exoskeleton
2. Acquire knowledge on the mechanism of chitin biosynthesis, chitin-protein interactions in body wall
3. Understand the physiology of digestive enzymes in phytophagous, wood boring and wool feeding insects
4. Acquire knowledge on detailed physiology of nervous, excretion, reproductive, respiratory and circulatory mechanisms
5. Gain knowledge on endocrine system and insect hormones
6. Familiarize with insect growth and development, polyphenism and diapause

Theory

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials indifferent types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

Endocrine system and insect hormones, physiology of insect growth and development- metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

References

1. Kerkut, G.A and Gilbert, L.I. (1985). *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford, New York.
2. Muraleedharan, K. (1997). *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.

21AG3092 ADVANCED INSECTICIDE TOXICOLOGY

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Latest advancements in the field of insecticide toxicology
2. Biochemical and physiological target sites of insecticides
3. Pesticide resistance mechanisms in insects

Course Outcomes:

On completion of this course, students will be able to

1. Understand the penetration and distribution of insecticides in insect systems
2. Identify the problems associated with pesticide residues in agriculture ecosystem
3. Understand the biochemical and physiological target sites of insecticides in insects
4. Learn about insecticide laws and standards, and good agricultural practices
5. Gain knowledge on biochemical and biological techniques for detection of insecticide resistance in insects
6. Acquire and adopt different advanced methods for estimation of insecticide residues

Theory

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides. Joint action of insecticides; activation, synergism and potentiation.

Problems associated with pesticide use in agriculture pesticide resistance-resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

Practical

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

References

1. Busvine, J.R. (1971). *A Critical Review on the Techniques for Testing Insecticides*. CABI, London.
2. Dhaliwal, G.S and Koul, O. (2007). *Biopesticides and Pest Management*. Kalyani Publications New Delhi.
3. Hayes, W.J and Laws, E.R. (1991). *Handbook of Pesticide Toxicology*. Academic Press, New York.
4. Ishaaya, I and Degheele (Eds.). (1998). *Insecticides with Novel Modes of Action*. Narosa Publications, House, New Delhi.
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8. Prakash, A and Rao, J. (1997). *Botanical Pesticides in Agriculture*. Lewis Publications New York.

21AG3093 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Molecular techniques in entomological research
2. Biotechnological approaches in sericulture and apiculture
3. Genes of interest in entomological research

Course Outcomes:

On completion of this course, students will be able to

1. Understand the techniques used in molecular biology
2. Learn about the DNA and RNA analysis in insects
3. Understand the DNA recombinant technology and identification of genes for characters of interest
4. Gain knowledge on the genetic improvement of natural enemies
5. Acquire knowledge on insect gene transformation in relation to silkworms and honey bees
6. Develop a resistance management strategy in transgenic crops

Theory

Introduction to molecular biology; techniques used in molecular biology. DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, Bt and entomopathogenic fungi. Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, neuropeptides. Transgenic plants for pest resistance and diseases.

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA fingerprinting for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies. DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

Practical

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

References

1. Bhattacharya, T.K., Kumar, P and Sharma, A. (2007). *Animal Biotechnology. 1st Ed.*, Kalyani Publications New Delhi.
2. Hagedon, H.H., Hilderbrand, J.G., Kidwell, M.G. and Law, J.H. (1990). *Molecular Insect Science*. Plenum Press, New York.
3. Oakeshott, J and Whitten, M.A. (1994). *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.

4. Rechcigl J.E and Rechcigl N.A. (1998). *Biological and Biotechnological Control of Insect Pests*. Lewis Publications North Carolina.
5. Roy, U and Saxena, V. (2007). *A Hand Book of Genetic Engineering. 1st Ed.*, Kalyani Publications New Delhi.
6. Singh, B.D. (2008). *Biotechnology (Expanding Horizons)*. Kalyani Publications New Delhi.
7. Singh, P. (2007). *Introductory to Biotechnology. 2nd Ed.* Kalyani Publications New Delhi.

21AG3094 ADVANCED INTEGRATED PEST MANAGEMENT

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Recent problems with alien pest and use of IPM
2. Surveillance and data base management as a tool in IPM
3. Successful national and international case histories of integrated pest management

Course Outcomes:

On completion of this course, students will be able to

1. Understand the principles and concepts of IPM
2. Acquire knowledge on data base management, simulation techniques and system analysis
3. Assess the new technologies in genetic engineering and their progress and limitations in IPM Programs
4. Acquire and adopt different strategies in pesticide resistance management.
5. Familiarize with new technologies and their progress and limitations in IPM Programs
6. Understand the scope and limitations of bio-intensive and ecological based IPM Programs

Theory

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modelling. Case histories of national and International Programs, their implementation, adoption and criticisms, global trade and risk of invasive pests.

Genetic engineering and new technologies- their progress and limitations in IPM Programs, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM Programs. Application of IPM to farmers' real time situations.

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

References

1. Dhaliwal, G.S and Arora, R. (2003). *Integrated Pest Management – Concepts and Approaches*. Kalyani Publications, New Delhi.
2. Dhaliwal, G.S, Singh, R and Chhillar, B.S. (2006). *Essentials of Agricultural Entomology*. Kalyani Publications, New Delhi.
3. Flint, M.C and Bosch, R.V. (1981). *Introduction to Integrated Pest Management*. Springer, Berlin.
4. Koul, O and Cuperus, G.W. (2007). *Ecologically Based Integrated Pest Management*. CABI, London.
5. Koul, O., Dhaliwal, G.S and Curperus, G.W. (2004). *Integrated Pest Management -Potential, Constraints and Challenges*. CABI, London.
6. Maredia, K.M., Dakouo, D and Mota-Sanchez, D. (2003). *Integrated Pest Management in the Global Arena*. CABI, London.
7. Metcalf, R.L and Luckman, W.H. (1982). *Introduction of Insect Pest Management*. John Wiley & Sons, New York.
8. Norris, R.F., Caswell-Chen, E.P and Kogan, M. (2002). *Concept in Integrated Pest Management*. Prentice Hall, New Delhi.
9. Pedigo, R.L. (1996). *Entomology and Pest Management*. Prentice Hall, New Delhi.
10. Subramanyam, B and Hagstrum, D.W. (1995). *Integrated Management of Insects in Stored Products*. Marcel Dekker, New York.

21AG3095 INSECT BEHAVIOUR

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Behavioural responses in natural selection
2. Adaptability and various survival strategies in insects
3. Manipulating the insect behaviour for pest management

Course Outcomes:

After completion of this course, the student will be able to

1. Understand role of behaviour and behavioural polymorphism in natural selection and genetic control
2. Familiarize with concept of insect communication and orientation
3. Understand the reproductive and social behavior in insects
4. Gain knowledge on insect plant interaction
5. Understand the role of insect behavior in communication and defense as a tool for host selection
6. Acquire knowledge on behavioural manipulation as potential tool in pest management

Theory

Defining Behaviour- Concept of Umwelt, instinct, fixed action patterns, imprinting, complex behaviour, induced behaviour, learnt behaviour and motivation. History of Ethology- development of behaviourism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

Orientation- Forms of primary and secondary orientation including taxis and kinesis; Communication- primary and secondary orientation, response to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals. Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behaviour.

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

Practical

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram podborer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

References

1. Ananthkrishnan, TN. (Ed.). (1994). *Functional Dynamics of Phytophagous Insects*. Oxford & IBH, New Delhi.
2. Awasthi VB. (2001). *Principles of Insect Behaviour*. Scientific Publications Jodhpur.
3. Bernays, E.A and Chapman RF. (1994). *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, London.
4. Brown, LB. (1999). *The Experimental Analysis of Insect Behaviour*. Springer, Berlin.
5. Krebs J.R and Davies NB. (1993). *An Introduction to Behavioural Ecology*. 3rd Ed. Chapman & Hall, London.
6. Manning, A and Dawkins MS. (1992). *An Introduction to Animal Behaviour*. Cambridge University Press, USA.
7. Mathews, R.W and Mathews, J.R. (1978). *Insect Behaviour*. A Wiley- Inter Science Publications John Wiley & Sons, New York.

21AG3096 RECENT TRENDS IN BIOLOGICAL CONTROL

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Role of biocontrol agents in pest management
2. Advanced techniques for mass multiplication and field release of biocontrol agents
3. Scope of biocontrol agents in organic farming system

Course Outcomes:

On completion of this course, students will be able to

1. Understand the scope of classical biological control and augmentative biocontrol
2. Identify the dynamics of biocontrol agents against target pest populations
3. Understand the mass culturing techniques of biocontrol agents
4. Identify the scope of genetically engineered microbes and parasitoids in biological control
5. Develop a holistic knowledge on large-scale production of biocontrol agents
6. Apply the knowledge for overcoming insecticide resistance pest population using biocontrol agents

Theory

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents vis-à-vis target pest populations. Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation. Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Practical

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

References

1. Burges, H.D and Hussey, N.W. (Eds.). (1971). *Microbial Control of Insects and Mites*. Academic Press, London.
2. Coppel, H.C and James, W.M. (1977). *Biological Insect Pest Suppression*. Springer Verlag, Berlin.
3. De Bach, P. (1964). *Biological Control of Insect Pests and Weeds*. Chapman & Hall, London.
4. Dhaliwal, G.S and Koul, O. (2007). *Biopesticides and Pest Management*. Kalyani Publications, New Delhi.
5. Gerson, H and Smiley, R.L. (1990). *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.
6. Huffakar, C.B and Messenger, P.S. (1976). *Theory and Practices of Biological Control*. Academic Press, London.

21AG3097 ADVANCED HOST PLANT RESISTANCE

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Recent advances in resistance of plants to insects
2. Techniques for assessment and evaluation of resistance in crop plants
3. Biotechnological approaches in host plant resistance

Course Outcomes:

On completion of this course, students will be able to

1. Acquire knowledge on techniques and determination of categories of plant resistance
2. Understand the importance of plant resistance
3. Learn about physical and chemical environment conferring resistance in plants
4. Understanding mechanisms of resistance for orientation, feeding, oviposition etc.,
5. Identify the plant resistance based on genotype expression
6. Apply the advanced biotechnological tools in host plant resistance

Theory

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors. Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors. Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding. Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Practical

Understanding mechanisms of resistance for orientation, feeding, oviposition etc., allelochemical bases of insect resistance; macro culturing of test insects like aphids, leaf/plant hoppers, mites and stored grain pests; field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

References

1. Panda, N. (1979). *Principles of Host Plant Resistance to Insects*. Allenheld, Osum & Co., New York.
2. Rosenthal, G.A and Janzen, D.H. (Eds.). (1979). *Herbivores – their Interactions with Secondary Plant Metabolites. Vol. I, II*. Academic Press, New York.
3. Sadasivam, S and Thayumanavan, B. (2003). *Molecular Host Plant Resistance to Pests*. Marcel Dekker, New York.
4. Smith, C.M., Khan, Z.R and Pathak, M.D. (1994). *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida.

21AG3098 ADVANCED ACAROLOGY

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Identification of economically important groups of Acari causing damage to crop plants
2. Management of economical important species of mites in agriculture
3. Management of phytophagous mites using acaricides and predatory mites

Course Outcomes:

On completion of this course, students will be able to

1. Understand the morphology and phylogeny of mites of economic importance
2. Acquire Knowledge on ecology and population dynamics of mite families in India
3. Identify the taxonomic characteristics of mite species
4. Understand the biotic and abiotic factors influencing the population of mites
5. Explain about the mass production and utilization of predatory mites
6. Gain knowledge on mite species related to veterinary, public health and storage acarology

Theory

Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

Management of economical important species of mites in agriculture, veterinary and public health; storage acarology. Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites. Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

Practical

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens etc.

References

1. Evans, G.O. (1992). *Principles of Acarology*. CABI, London.
2. Gerson, H and Smiley, R.L. (1990). *Acarine Biocontrol Agents- An Illustrated Key and Manual*. Chapman & Hall, New York.
3. Gupta, S.K. (1985). *Handbook of Plant Mites of India*. Zoological Survey of India, Calcutta.
4. Krantz, G.W. (1970). *A Manual of Acarology*. Oregon State University Book Stores, Corvallis, Oregon.
5. Sadana, G.L. (1997). *False Spider Mites Infesting Crops in India*. Kalyani Publ. House, New Delhi.

21AG3117 ADVANCED MYCOLOGY

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Recent advances in Mycology
2. Current scenario in taxonomical classification
3. The reproduction behavior of fungi

Course Outcomes:

On completion of this course, students will be able to

1. Gain knowledge on historical development and advances in mycology
2. Explain the different methods of fungal taxonomy
3. Interpret the relationship between fungal complex

4. Outline the various sexual and asexual reproduction behavior of fungi
5. Acquire knowledge on genetic variability of fungal pathogens
6. Describe the mechanism of nuclear inheritance and biodegradation.

Theory

General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi. Population biology, pathogenic variability/vegetative compatibility. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

Practical

Study of conidiogenesis - phialides, porospores, arthrospores. Study of fruit bodies in Ascomycotina. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of representative plant pathogenic genera from different groups of fungi.

References

1. Alexopoulos, C.J., Mimms, C.W and Blackwell, M. (1996). *Introductory mycology*. John Wiley and Sons, New York.
2. Dube, H.C. (2005). *An introduction to fungi*. 3rd Ed. Vikas Publishing House, New Delhi.
3. Kirk, P.M., Cannon, P.F, David, J.C and Stalpers, J.A. (Eds.). (2001). *Ainsworth and bisby's dictionary of fungi*. 9th Ed., CABI, Wallington.
4. Ulloa, M and Hanlin, R.T. (2000). *Illustrated dictionary of mycology*. APS, St. Paul, Minnesota.
5. Webster, J and Weber, R. (2007). *Introduction to fungi*. Cambridge Univ. Press, Cambridge.

21AG3118 ADVANCED VIROLOGY

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. The advanced techniques and new developments in the field of plant virology
2. Transmission studies and genome organization of plant viruses
3. Molecular mechanisms in host virus interaction

Course Outcomes:

On completion of this course, students will be able to

1. Gain knowledge on virus-vector relationship and transmission behavior of plant viruses
2. Discuss about the replication strategies and variability among the viral strains
3. Explain the methods for identification of different viruses
4. Understand the genome organization, replication, transcription and translational strategies of different plant viral groups
5. Interpret the molecular mechanisms between host virus interaction
6. Acquire knowledge on genetic engineering with plant viruses

Theory

Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains. Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction. Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucurmo, ilar and tospoviruses. Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions. Genetic engineering with plant viruses, viral suppressors, RNAi dynamic, resistant genes. Viruses' potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture. Origin, evolution and inter-relationship with animal viruses.

Practical

Purification of virus(es), SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for

collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing annotation of genes.

References

1. Davies. (1997). *Molecular plant virology: Replication and gene expression*. CRC Press, Florida.
2. Fauquet *et al.* (2005). *Virus taxonomy*. VIII Report of ICTV. Academic Press, New York.
3. Gibbs, A and Harrison, B. (1976). *Plant virology - The principles*. Edward Arnold, London.
4. Jones, P., Jones, P.G and Sutton, J.M. (1997). *Plant molecular biology: essential techniques*. John Wiley and Sons, New York.
5. Khan, J.A and Dijkstra. (2002). *Plant viruses as molecular pathogens*. Howarth Press, New York.
6. Maramorosch, K., Murphy, F.A and Shatkin, A.J. (1996). *Advances in virus research*. Vol. 46. Academic Press, New York.
7. Pirone, T.P and Shaw, J.G. (1990). *Viral genes and plant pathogenesis*. Springer Verlag, New York.
8. Roger Hull. (2002). *Mathew's plant virology* (4th Ed.). Academic Press, New York.
9. Thresh, J.M. (2006). *Plant virus epidemiology*. Advances in Virus Research 67. Academic Press, New York.

21AG3119 ADVANCED BACTERIOLOGY

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. The advanced techniques and new developments in the field of plant bacteriology
2. Current scenario in taxonomy of phytopathogenic bacteria
3. Molecular mechanisms in host bacterial interaction

Course Outcomes:

On completion of this course, students will be able to

1. Gain knowledge on characterization and identification of phytopathogenic bacteria
2. Interpret the mechanisms of disease development on host plants
3. Describe the host-bacterial interactions
4. Discuss the genetic engineering for management of bacterial plant pathogens
5. Explain the epidemiology in relation to bacterial plant pathogens
6. Impart knowledge on beneficial prokaryotes and their role in disease management

Theory

Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria. Current trends in taxonomy of phytopathogenic prokaryotes. Role of enzyme, toxin, exopolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumefaciens*). Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein. Molecular variability among phytopathogenic prokaryotes and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens - gene silencing, RNAi technology. Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit. Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Practical

Pathogenic studies and race identification; plasmid profiling of bacteria; fatty acid profiling of bacteria; RAPD profiling of bacteria and variability status; Endospore, Flagellar staining; test for secondary metabolite production, cyanides, EPS, siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.

References

1. Dale, J.W and Simon, P. (2004). *Molecular genetics of bacteria*. John Wiley and Sons, New York.
2. Garrity, G.M., Krieg, N.R and Brenner, D.J. (2006). *Bergey's manual of systematic bacteriology: The proteobacteria*. Vol. II. Springer Verlag, New York.
3. Gnanamanickam, S.S. (2006). *Plant-associated Bacteria*. Springer Verlag, New York.
4. Mount, M.S and Lacy, G.H. (1982). *Plant pathogenic prokaryotes*. Vols. I, II. Academic Press, New York.
5. Sigeo, D.C. (1993). *Bacterial plant pathology: cell and molecular aspects*. Cambridge Univ. Press, Cambridge.
6. Starr, M.P. (1992). *The prokaryotes*. Vols. I – IV. Springer Verlag, New York.

21AG3120 MOLECULAR BASIS OF HOST PATHOGEN INTERACTION

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Mechanisms in molecular basis of host-pathogen interaction
2. Defense responses against plant pathogenic attack
3. Biotechnology and disease management approaches

Course Outcomes:

On completion of this course, students will be able to

1. Explain about the importance and role of biotechnological tools in plant pathology
2. Outline the basic concepts and principles in host pathogen relationship
3. Explain the molecular basis of host-pathogen interaction
4. Discuss about the induction of defense responses in plant system
5. Explain about the biotechnological approaches in development of disease resistance plants
6. Discuss about the biosafety issues related to GM crops

Theory

Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship. Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction. Induction of defense responses- pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing. Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical

Protein, DNA and RNA isolation, Plasmid's extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

References

1. Chet, I. (1993). *Biotechnology in plant disease control*. John Wiley and Sons, New York.
2. Gurr, S.J., McPherson M.J and Bowles D.J. (Eds.). (1992). *Molecular plant pathology - A practical approach. Vols. I and II*, Oxford Univ. Press, Oxford.
3. Mathew, J.D. (2003). *Molecular plant pathology*. Bios Scientific Publications UK.
4. Ronald, P.C. (2007). *Plant-pathogen interactions: Methods in molecular biology*. Humana Press, New Jersey.
5. Stacey, G and Keen, T.N. (Eds.). (1996). *Plant microbe interactions. Vols. I-III. Chapman and Hall, New York, Vol. IV. APS Press, St. Paul, Minnesota.*

21AG3121 PRINCIPLES AND PROCEDURES OF CERTIFICATION

Credits: 1(1+0)

Course Objectives:

To impart knowledge on

1. Certification procedures for seed and planting material
2. National regulatory mechanism and seed certification standards
3. Seed health testing procedures

Course Outcomes:

On completion of this course, students will be able to

1. Gain knowledge on introduction to seed certification and international scenario in certification system
2. Understand the basics for testing physical and genetic purity of seeds
3. To know the quality control specifications in seed certification
4. Discuss about the national status of seed health in seed certification
5. Gain knowledge on accreditation procedures for seed testing laboratories
6. Recognize the role of seed certification in national and international trade

Theory

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc. Fixing tolerance limits for diseases and insect pests in certification and quality control

Programs. Methods used in certification of seeds, vegetative propagules and in vitro cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

References

1. Hutchins, D and Reeves, J.E. (Eds.). (1997). *Seed health testing: Progress towards the 21st Century*. CABI, UK.
2. Tunwar, N.S and Singh, S.V. (1988). *Indian minimum seed certification standards*. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.

E Books

1. *Association of official seed certifying*. Agencies.<http://www.aosca.org/index.htm>
2. *ISHI-veg manual of seed health testing methods*.
http://www.worldseed.org/enus/international_seed/ishi_vegetable.html
3. *ISHI-F Manual of seed health testing methods*.
http://www.worldseed.org/enus/international_seed/ishi_f.html
4. *ISTA Seed health testing methods*.<http://www.seedtest.org/en/content---1--1132--241.html>
5. *US National seed health system*. <http://www.seedhealth.org/>

21AG3122 PLANT BIOSECURITY AND BIOSAFETY

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Plant biosecurity and biosafety issues in agriculture.
2. International standards for phytosanitary measures and pest risk analysis
3. Biosafety policies and regulatory mechanism

Course Outcomes:

On completion of this course, students will be able to

1. Outline the history, concepts and components of biosecurity
2. Understand the national regulatory mechanism and international agreements/ conventions
3. Develop forecasting system and pest risk assessment models for plant biosecurity
4. Apply the knowledge of Global Positioning System and Geographic Information System in plant biosecurity
5. Acquire the knowledge on issues related to release of genetically modified crops.
6. Understand the Cartagena protocol on biosafety and its implications

Theory

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases. National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity. Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

References

1. Randhawa, G.J., Khetarpal, R.K., Tyagi, R.K and Dhillon, B.S. (Eds.). (2001). *Transgenic crops and biosafety concerns*. NBPGR, New Delhi.
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21AG3123 ADVANCES IN NEMATODE MANAGEMENT

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Identification of promising bio-control agents
2. Defense mechanisms on host nematode interaction
3. Latest developments and trends in nematode management.

Course Outcomes:

On completion of this course, students will be able to

1. Gain knowledge on isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents.
2. Understand the mass culturing protocols of potential bio-control agents.
3. Explain the resistance mechanisms on host nematode interaction
4. Discuss about the nematode management modules for integrated pest and disease management in cropping systems.
5. Interpret the nematode management options and approaches for organic farming and precision farming.
6. Gain knowledge on application of GIS and GPS technology for surveillance and management.

Theory

Isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents- predacious and parasitic fungi; nematotoxic fungal culture filtrates. Isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents- parasitic and nematode antagonistic bacteria; predacious mites and predacious nematodes. Mass culturing, formulation, quality control, bio-safety and registration protocols of bio-control agents. Phytoalexins, allelochemicals, phytotherapeutic substances, novel nematicides, deployment of resistant varieties and non-host crops in nematode suppressive cropping systems, emergence of resistance breaking biotypes, recent regulatory provisions and methods, quarantine and disinfection. Nematode management modules for integrated pest and disease management in cropping systems. Nematode management options and approaches for organic farming and precision farming. Application of GIS and GPS technology for surveillance and management.

Practical

Greenhouse experiments on the efficacy of fungal and bacterial bio-control agents, botanicals.

References

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21HO3127 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. The basic principles of growth and development in horticultural crops.
2. The biosynthesis of growth regulators and inhibitors in horticultural crops.
3. The developmental physiology and biochemistry at various stages of growth in horticultural crops.

Course Outcomes:

On completion of this course, students will be able to

1. Describe the basic concepts and parameters of growth and development.
2. Discuss on the biosynthesis of various growth regulators and inhibitors.
3. Enumerate on the physiology at various stages of growth.
4. Outline on the growth and developmental process during stress situations.

5. Discuss on the manipulation of growth and development.
6. Overview on the molecular and genetic approaches in plant growth development.

Theory

Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis. Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism. Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development. Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

References

1. Buchanan, B., Gruissem, W and Jones, R. (2002). *Biochemistry & molecular biology of plants*. John Wiley & Sons.
2. Epstein, E. (1972). *Mineral nutrition of plants: Principles and perspectives*. Wiley.
3. Fosket, D.E. (1994). *Plant growth and development: a molecular approach*. Academic Press.
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21HO3128 TROPICAL AND DRY LAND FRUIT PRODUCTION

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. Production technology of tropical and dry land fruit crops.
2. The strategies of training and pruning techniques for major tropical and dry land fruit crops.
3. The techniques of high productivity and post-harvest handling operations.

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the production technology of major tropical and dryland fruits.
2. Identify the nutritional disorders of fruit crops.
3. Enumerate the pruning and training practices in fruit crops.
4. Demonstrate the techniques of high productivity in fruit crops.
5. Discuss the role of rootstock in fruit crops propagation.
6. Elucidate the post-harvest handling of major tropical and dry land fruit crops.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports related to crops viz., mango and banana, citrus and papaya, guava, sapota and jackfruit, pineapple, annona and avocado, aonla, pomegranate, phalsa and ber, minor fruits of tropics.

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, project preparation for establishing commercial orchards.

References

1. Bose, T.K., Mitra, S.Kand Rathore, D.S. (Eds.). (1988). *Temperate fruits -Horticulture*. Allied Publishing.
2. Bose, T.K., Mitra, S.Kand Sanyal, D. (Eds.). (2001). *Fruits -Tropical and subtropical*. Naya Udyog.
3. Chadha, K.Land Pareek, O.P. (Eds.). (1996). *Advances in Horticulture*. Vols. IIIIV.Malhotra Publication House.
4. Nakasone, H.Yand Paul, R.E. (1998). *Tropical fruits*. CABI.
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21HO3129 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. The principles of biodiversity and strategies for germplasm conservation in fruit crops.
2. The centers of origin of fruit crops.
3. The methods of conservation of genetic resources in fruit crops.

Course Outcomes:

On completion of this course, students will be able to

1. Describe the centers of origin in fruit crops.
2. Discuss on the various conservation methods of genetic resources.
3. Discuss the collection of germplasm conservation of fruit crops.
4. Explain on the Intellectual Property Rights (IPR).
5. Describe the various centers involved in the germplasm conservation of fruit crops.
6. Outline on the GIS and Geographical indication of fruit crops.

Theory

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity. Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ*. Germplasm conservation- problem of recalcitrancy – cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory ofgermplasm, introduction of germplasm, plant quarantine. Intellectual property rights, regulatory horticulture. Detection of geneticconstitution of germplasm and maintenance of core group. GIS and documentation of local biodiversity, geographical indication. Crops include mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

References

1. Frankel, O.H and Hawkes, J.G. (1975). *Crop genetic resources for today and tomorrow*. Cambridge University Press.
2. Peter, K.Vand Abraham, Z. (2007). *Biodiversity in horticultural crops*. Vol. I. Daya Publishing House.
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21HO3130 PROPAGATION AND NURSERY MANAGEMENT OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. The basic principles of plant propagation.

2. Overview of propagation techniques.
3. The methods of propagation of commonly cultivated fruit crops.

Course Outcomes:

On completion of this course, students will be able to

1. Demonstrate the propagation and nursery management techniques for horticultural crops.
2. Describe the various structures used for propagation.
3. Select the mother plant and prepare the propagation plant materials.
4. Handle the tools used in propagation and achieve skill-oriented knowledge.
5. Plan appropriate management of nursery and young propagated plants.
6. Outline the micro-propagation techniques for horticultural crops.

Theory

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth. Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of cuttings, factors affecting- nutritional, physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principles and methods. Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank. Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, organogenesis, meristem culture, somatic embryogenesis. Hardening, packing and transport of micro propagules. Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Study of seed germination and breaking dormancy, study of vegetative propagation methods, anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micro propagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, hardening. Visit to TC labs and nurseries.

References

1. Hartmann, H.T., Kester, D.E., Davies, F.T and Greneve, R.L. (2006). *Plant propagation, principles and practices*. Prentice Hall of India Private Ltd., New Delhi.
2. Prasad, S and Kumar, U. (2005). *Principle of horticulture*. 3rd edition, Agrobios, India.
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5. Chadha, K.L. (2001). *Hand book of horticulture*. ICAR, New Delhi.

21HO3131 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. The production technology of subtropical and temperate fruit crops.
2. The strategies of training and pruning techniques for subtropical and temperate fruit crops.
3. The techniques of high productivity and post-harvest handling operations for subtropical and temperate fruit crops.

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the production technology of subtropical and temperate fruits.
2. Identify the nutritional disorders of subtropical and temperate fruit crops.
3. Enumerate the pruning and training practices of subtropical and temperate fruits.
4. Demonstrate the techniques of high productivity in fruit crops.
5. Discuss the role of rootstock in fruit crops propagation.
6. Explain the post-harvest handling of subtropical and temperate fruit crops.

Theory

Commercial varieties of regional, national and international importance, eco physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage,

transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support of Apple, pear, quince, grapes, plums, peach, apricot, cherries, hazelnut, litchi, loquat, persimmon, kiwi fruit, strawberry, nuts- walnut, almond, pistachio, pecan, minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate.

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, project preparation for establishing commercial orchards.

References

1. Bose, T.K., Mitra, S.K and Sanyal, D. (Ed.). (2002). *Fruits of India – tropical and sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
2. Chadha, K. L and Pareek, O.P.(Eds.).(1996). *Advances in horticulture*. Vol. I.Malhotra Publishing House.
3. Chadha, K. L and Shikhamany, S. D. (1999). *The Grape: Improvement, production and post-harvest management*. Malhotra Publishing House.
4. Janick, J and Moore, J.N. (1996). *Fruit breeding*. Vols.I-III. John Wiley & Sons.
5. Nijjar, G.S. (Eds.). (1977). *Fruit breeding in India*. Oxford & IBH.
6. Radha, T and Mathew, L. (2007). *Fruit crops*. New India Publisher Agency.
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21HO3132 CANOPY MANAGEMENT IN FRUIT CROPS

Credits: 2 (1+1)

Course Objectives:

To impart basic knowledge on

1. The practices of canopy management in fruit crops.
2. The canopy types and structures.
3. The canopy development and management in various fruit crops.

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the principles of canopy management.
2. Identify the different types distribution of tree canopies.
3. Mention the techniques in canopy management.
4. Enumerate the pruning and training practices for canopy management.
5. Discuss the role of rootstock and scion in canopy management.
6. Explain the canopy development and management in various fruit crops.

Theory

Canopy management - importance and advantages; factors affecting canopy development. Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies. Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion. Canopy management through plant growth inhibitors, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

Practical

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

References

1. Chadha, K.L and Shikhamany, S.D. (1999). *The Grape, improvement, production and post-harvest management*. Malhotra Publishing House.
2. Pradeepkumar, T., Suma, B., Jyothibhaskar and Satheesan, K.N. (2008). *Management of horticultural crops*. New India Publisher Agency.

21HO3133 BREEDING OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. The approaches for crop improvement in fruit crops.

2. Overview of resistance breeding for biotic and abiotic stresses of fruit crops.
3. The biotechnological interventions of fruit crops.

Course Outcomes:

On completion of this course, students will be able to

1. Explain the breeding objectives of fruits.
2. Discuss the species, cultivars and genetic resources of fruit crops.
3. Outline on the blossom biology of major fruits.
4. Describe the approaches for crop improvement.
5. Discuss on the resistance breeding for biotic and abiotic stresses.
6. Outline on the biotechnological interventions in fruits.

Theory

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement -introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops. Crops include mango, banana, pineapple, citrus, grapes, guava, sapota, jackfruit, papaya, custard apple, aonla, avocado, ber, mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts, apple, pear, plums, peach, apricot, cherries and strawberry.

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding Program for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement.

References

1. Bose, T.K., Mitra, S.K and Sanyal, D. (Eds.). (2002). *Fruits of India – Tropical and sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
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6. Radha, T and Mathew, L. (2007). *Fruit crops*. New India Publisher Agency.
7. Singh, S., Shivankar, V.J., Srivastava, A.K. and Singh, I.P. (Eds.). (2004). *Advances in citriculture*. Jagminder Book Agency.

21HO3136 ADVANCES IN PRODUCTION OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Recent techniques in production technology of fruit crops
2. Recent advances in the propagation of fruit crops
3. Recent trends in orchard management

Course Outcomes:

On completion of this course, students will be able to

1. Explain the national and international scenario of fruit production
2. Demonstrate on the advanced propagation techniques of fruit crops
3. Discuss on the recent achievements in crop regulation
4. Elucidate on the advances in high density and ultra-high density planting systems and crop modelling
5. Explain on the modern approaches in water and nutrient management in fruit crops
6. Discuss the strategies to overcome biotic and abiotic stress effects

Theory

National and International scenario in fruit production, Recent advances in propagation – rootstock influence, planting systems, High density planting, crop modelling, Precision farming, decision support systems, aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management (TQM), Current topics. Crops viz., Mango, banana, papaya, grapes,

citrus, guava, sapota, pomegranate, aonla, pineapple, avocado, jack fruit, fig, apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, estimating nutrient deficiency, estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

References

1. Bose, T. K., Mitra, S. K and Rathore, D. S. (Eds.). (1988). *Temperate fruits –Horticulture*. Allied Publishers
2. Bose, T. K., Mitra, S. K and Sanyal, D. (Eds.). (2001). *Fruits -Tropical and subtropical*. Naya Udyog
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4. Chadha, K. L. and Pareek, O. P. (Eds.). (1996). *Advances in horticulture*. Vols. IIIIV. Malhotra Publishing House
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6. Nakasone, H. Y and Paull, R. E. (1998). *Tropical fruits*. CABI
7. Radha, T and Mathew, L. (2007). *Fruit crops*. New India Publishing Agency

21HO3137 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. The hormonal biosynthesis of growth regulators and inhibitors
2. Growth regulation aspects at various stages of fruit growth
3. Overview on the molecular approaches in crop growth regulation

Course Outcomes:

On completion of this course, students will be able to

1. Describe the eco-physiological influences on growth and development of fruit crops
2. Explain on the biosynthesis of growth regulators and retardants
3. Enumerate on the physiology of plant at various stages of growth
4. Discuss on the root and canopy regulation of fruits
5. Elucidate on the canopy management for orchards
6. Overview on the molecular and genetic approaches in crop growth regulation

Theory

Eco-physiological influences on growth and development of fruit crops flowering, fruit set, Crop load and assimilate partitioning and distribution. Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phyto-hormones, internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards. Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruit set and development, fruit drop, parthenocarp, fruit maturity and ripening and storage, molecular approaches in crop growth regulation, current topics.

Practical

Root- shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruit set and fruit development stages.

References

1. Buchanan, B., Gruissem, W and Jones, R. (2002). *Biochemistry and molecular biology of plants*. John Wiley & Sons
2. Epstein, E. (1972). *Mineral nutrition of plants: Principles and Perspectives*. Wiley
3. Fosket, D. E. (1994). *Plant growth and development: A Molecular Approach*. Academic Press
4. Leopold, A. C and Kriedemann, P. E. (1985). *Plant growth and development*. 3rdEd. McGraw-Hill
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7. Salisbury, F. B and Ross, C. W. (1992). *Plant physiology*. 4th Ed. Wadsworth

21HO3138 ADVANCES IN BREEDING OF FRUIT CROPS

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. Advanced methods in crop improvement of fruit crops
2. Breeding achievements in crop improvement of fruit crops
3. Recent trends in research of breeding tropical, subtropical and temperate fruit crops

Course Outcomes:

On completion of this course, students will be able to

1. Outline the breeding objectives for fruit crops
2. Discuss the evolutionary pattern of fruit crops
3. Explain the incompatibility systems of fruit crops
4. Explain the recent advances in crop improvement of fruit crops
5. Describe the resistance breeding in biotic and abiotic stresses of fruit crops
6. Overview on the recent molecular and transgenic approaches in breeding of fruit crops

Theory

Evolutionary mechanisms, adaptation and domestication, genetic resources, cytogenetics, cyto-morphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits, recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and inter varietal hybridization, mutation and polyploidy breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops. Crops viz., Mango, banana, papaya, grapes, citrus, guava, sapota, pineapple, avocado, apple, pear, plums, peaches, apricot, cherries and strawberry

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagens and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

References

1. Bose, T. K., Mitra, S. K and Sanyol, D. (Ed.). (2002). *Fruits of India – Tropical and sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog
2. Chadha, K. L and Pareek, O. P. (Eds.). (1996). *Advances in horticulture*. Vol. I. Malhotra Publishing House
3. Chadha, K. L and Shikhamany, S. D. (1999). *The Grape: Improvement, production and Post-Harvest Management*. Malhotra Publishing House
4. Gowen, S. (1996). *Banana and plantains*. Chapman & Hall
5. Janick, J and Moore, J. N. (1996). *Fruit breeding*. Vols. I-III. John Wiley & Sons
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7. Radha, T and Mathew, L. (2007). *Fruit crops*. New India Publishing Agency
8. Singh, S., Shivankar, V. J., Srivastava, A. K and Singh, I. P. (Eds.). (2004). *Advances in citriculture*. Jagminder Book Agency
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21HO3139 GENOMICS AND BIOINFORMATICS IN HORTICULTURE

Credits: 3 (2+1)

Course Objectives:

To impart basic knowledge on

1. Handling genomic databases
2. Sequence alignment and structure prediction
3. Applying the tools of genomics and bioinformatics in 'omics'

Course Outcomes:

On completion of this course, students will be able to

1. Identify a genome sequence and annotate its functions
2. Design gene-based primers for target traits
3. Perform the multiple sequence alignment to identify conserved regions
4. Study the functional structure of a protein and its physiochemical properties
5. Identify the coding and non-coding sequence of a gene
6. Analyze the metabolic pathway beneath a trait to assist genomic assisted breeding

Theory

Primer on bioinformatics and computational genomics, database fundamentals viz., biological databases, horticultural genome and protein databases, functional genomics. Dynamic programming sequence alignment, BLAST search engine, FASTA search engine, Microarrays- Microarray clustering and classification, terminologies and ontologies –Eco CYC knowledge base of E. Coli metabolism - Description of UMLS semantic network. Multiple Sequence Alignment, MSA algorithm descriptions, Clustal W, 1DMotifs, Algorithms and Databases, methods for sequence weighting, BLOCKS database, making BLOCK motifs, PROSITE database, 3D structure alignment, SCOP, DALI, LOCK, MUSTA algorithm for geometric hashing and multiple alignment. Hidden Markov models, molecular energetics and dynamics, protein structure prediction, genetic networks - Modeling and simulation of genetic regulatory systems- KEGG database of genes and gene pathways/networks – Eco CYC database of metabolic pathways in E. Coli -EGF-signal pathway modeling, Gene finding algorithms – Genome annotation assessment project for Arabidopsis, Comparative genomics algorithms, Genome Alignment. 3D structure computations, NMR, X-ray Crystallography, NMR Structure, Determination, X-ray Crystallography structure determination, distance geometry description, RNA secondary structure, Molecular modeling and drug discovery programs. Phylogenetic algorithms – Tree base database of phylogenetic information for plants mostly, tree of life page, samples from the tree of life, ribosomal database project, natural language processing, proteomics, 3D Motifs, applications and integration with horticulture, final thoughts.

Practical

Computers, operating systems and Programming languages, Internet Resources, Horticultural Genome and Protein Databases, BLAST/RNA Structure, Sequence Alignment, Microarray Data Analysis, Ontology, MSA, HMMs, Identification of Functional Sites in Structures, Protein Structure Prediction - Phylogenetics - Gene Finding - Molecular Modeling and Drug Discovery Software – Assignments.

References

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21HO3140 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. The classification of stress and its impacts
2. The crop modelling for stress situations
3. The techniques involved in the stress management

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the classification of stress
2. Discuss the metabolic changes induced by stress factors
3. Enumerate the crop modelling for stress situations
4. Describe the methods of stress management in fruit crops
5. Discuss on the water use efficiency
6. Elucidate the crop growth sustainability indices

Theory

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution - increased level of CO₂, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Crop modelling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti-transpirants and PGRs

in stress management, modeo-faction and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll flurosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate, etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and watershed locations.

References

1. Blumm, A. (1988). *Plant breeding for stress environments*. CRC
2. Christiansen, M. N and Lewis, C. F. (1982). *Breeding plants for less favourable environments*. Wiley Inter. Science
3. Gupta, U. S. (1990). *Physiological aspects of dry farming*
4. Hsiao, T. C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiology* 24:519-570
5. Kramer, P. J. (1980). Drought stress and the origin of adaptation. In: *Adaptation of plants to water and high temperature stress*. John Wiley & Sons
6. Levitt, J. (1972). *Response of plants to environmental stresses*. Academic Press
7. Maloo, S. R. (2003). *Abiotic stress and crop productivity*. Agrotech Publishing Academy
8. Mussell, H and Staples, R. (1979). *Stress physiology in crop plants*. Wiley Inter. Science
9. Nickell, L. G. (1983). *Plant growth regulating Chemicals*. CRC
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21HO3141 ENVIRONMENTAL HORTICULTURE

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Environmental system and its impact on horticulture crops
2. Advances in environmental management of horticultural crops
3. Strategies in pollution management of horticulture-based industries

Course Outcomes:

On completion of this course, students will be able to

1. Explain about the environmental systems and their impact on horticulture
2. Discuss about the geochemical and hydrological cycles
3. Outline the causes of global warming and its impact on horticulture
4. Describe about the habitat ecology and conservation
5. Discuss about the waste management in horticulture-based industries
6. Explain about the different environmental policies across the globe

Theory

Environmental complex, interaction of ecological factors in horticultural crop production, interaction of physiographic factors in horticultural crop production. Geo-chemical and hydrological cycles and their impact on ecosystems. Global warming- carbon trading role of greenhouse gases, elevated CO₂ and its impact on productivity of horticultural systems. Habitat ecology, changes in habitats and its impact on horticultural production, habitat analysis, conservation biology, domestication. Forest ecosystem and its evolution to a hortecosystem. Phyto-geography. Changes in land use pattern and its impact on horticultural crop production. Natural resource management in horti systems. Subsistence farming systems of the world threat and challenges. Environmental pollution in horti systems, chemicals, fertilizers, etc. Waste management in processing industry, phyto-remediation. Alternate farming systems, horticultural therapy, Environmental policy and legislation in India, International treaties and summit, biodiversity board, act, etc.

Practical

Phyto-sociological analysis, assessment of plant associations in natural and domestic systems, productivity assessment of various ecosystems, analysis and assessment of various phyto geographic zones, assessment of land

use changes and its impact on horticultural systems, assessment of biodiversity, pesticide residue analysis in horticultural produce.

References

1. Ashby, M. (1973). *Introduction to plant ecology*. Mac Millan Press
2. CSIR. (1971). *The wealth of India*. Vols. A-Z. CSIR
3. Daubenmire, R. F. (1959). *Plants and environment*. Wiley Eastern
4. Fall. (2001). *Tolerance of landscape plants to recycle water irrigation*. UC and ANR Publications
5. Mathew, I. P and Karikari, S. K. (1990). *Horticulture principles and practices*. Mac Millan Intermediate Agricultural Series
6. Prasad, S and Kumar, U. (2003). *Principles of horticulture*. Agrobios publications
7. Sasikumar, B., Krishna Murthy, B., Rama, J., Ravindran, P. N and Peter, K. V. (Eds.). (1999). *Biodiversity conservation and utilization of spices, medicinal and aromatic plants*. I ISR, Calicut
8. Singh, P. P. (2006). *Perspectives in plant ecology and environmental biology*. Scientific Publications

21HO3154 ADVANCES IN VEGETABLE PRODUCTION

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Latest developments and trends in production technology of major tropical and subtropical vegetables
2. The strategies of protected cultivation and seedling production of vegetables
3. The latest techniques of soil, crop and nutrient management in vegetables

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the recent trends in research in production technology of vegetables
2. Identify the problems associated with vegetable cultivation and take up location specific advanced research Programs
3. Enumerate the use of nanotechnology, biotechnology and IT tools in vegetable production
4. Demonstrate the use of new generation products and formulations in vegetable farming
5. Discuss the role of training, pruning and crop modulation procedures to enhance productivity of vegetables
6. Elucidate the methods of low cost, input efficient agro techniques to enhance productivity of vegetables

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of Crops viz., Tomato, brinjal, chilli, sweet pepper and potato, cucurbits, cabbage, cauliflower and knol-khol, bhendi, onion, cowpea, green peas and beans, amaranthus and drumstick, carrot, beet root and radish, sweet potato, tapioca, elephant foot yam and taro.

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; Portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like stomatal index, anatomy; photosynthesis; light intensity in different cropping situations; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dry land techniques for rainfed vegetable production; production constraints; analysis of different cropping systems in various situations like cold and hot conditions; vegetable waste recycling management; quality analysis; marketing survey of the above crops; visit to vegetable and fruit markets and packing houses.

References

1. Bose, T. K. and Som, N. G. (1986). *Vegetable crops of India*. Naya Prokash.
2. Bose, T. K., Kabir, J., Maity, T. K., Parthasarathy, V. A and Som, M. G. (2003). *Vegetable crops*. Vols. I-III. Naya Udyog.
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21HO3155 ADVANCES IN BREEDING OF VEGETABLE CROPS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

- Recent trends in breeding of tropical, subtropical and temperate vegetable crops grown in India
- The strategies of holistic breeding methods involving traditional and molecular methods of breeding
- The biotechnological tools in vegetable breeding

Course Outcomes:

On completion of this course, students will be able to

- Summarize the recent trends in breeding of vegetable crops
- Identify the recent trends in breeding objectives of vegetable crops
- Enumerate the use of molecular markers in stress resistance breeding
- Demonstrate the techniques of biotechnological tools in vegetable breeding
- Discuss the role of a holistic breeding strategy for vegetable improvement
- Elucidate the breeding strategy for climate change adaptation of vegetables

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, inter-specific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding, biotechnological tools in breeding and their achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of crops viz., Tomato, brinjal, chilli, sweet pepper and potato, cucurbits, cabbage, cauliflower and knol-khol, bhendi, onion, peas and beans, amaranthus and drumstick, carrot, beet root and radish, sweet potato, tapioca, elephant foot yam and taro.

Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

References

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- Chadha, K. L., Ravindran, P. N and Sahijram, L. (2000). *Biotechnology in horticultural and plantation crops*. Malhotra Publishing House.
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21HO3156 PROTECTED CULTIVATION OF VEGETABLE CROPS

Credits: 2 (1+1)

Course Objectives:

To impart knowledge on

1. Recent trends in growing of vegetable crops under protected environmental conditions
2. The strategies of developing location specific protected structures for vegetable cultivation
3. The techniques of crop management in protected cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the recent trends in growing of vegetable crops under protected environmental conditions
2. Identify appropriate location specific protected structures for vegetable cultivation
3. Production of seeds and seedlings in protected structures
4. Demonstrate the appropriate agro-techniques in protected cultivation
5. Nutrient and soil management for vegetable cultivation in protected structures
6. Designing appropriate protected structures

Theory

Importance and scope of protected cultivation of vegetable crops; principles of protected cultivation, energy management, low-cost structures; training methods; engineering aspects. Regulatory structures used in protected structures; types of greenhouse/ polyhouse/ net house, hot beds, cold frames, effect of environmental factors, viz. temperature, light, CO₂ and humidity on growth of different vegetables, manipulation of CO₂, light and temperature for vegetable production, fertigation. Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover. Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures. Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production, Crops viz., Tomato, capsicum, cucumber, melons and lettuce.

Practical

Study of various types of structures, methods to control temperature, CO₂, light, media, training and pruning, maintenance of parental lines and hybrid, seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in green house; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

References

1. Anonymous. (2003). *Proc. All India seminar on potential and prospects for protective cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003
2. Chandra, S and Som, V. (2000). *Cultivating vegetables in green house*. Indian Horticulture
3. Prasad, S and Kumar, U. (2005). *Greenhouse management for horticultural crops*. 2nd Ed. Agrobios
4. Tiwari, G. N (2003). *Greenhouse technology for controlled environment*. Narosa Publishing House

21HO3157 BIOTECHNOLOGY IN VEGETABLE CROPS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Recent trends in biotechnology tools for crop improvement of vegetable crops
2. Development of vegetable varieties with biotic and abiotic resistance
3. Utilization of biotechnological tools in vegetable breeding and classification

Course Outcomes:

On Completion of this course, students will be able to

1. Summarize the recent trends in biotechnology tools employed in crop improvement of vegetable crops
2. Identify the strategy for development of vegetable varieties with biotic and abiotic resistance
3. Utilize the traditional and modern methods of crop improvement in vegetables
4. Demonstrate the use of molecular markers in vegetable breeding and classification
5. Discuss the role of nano products in vegetable production
6. Develop location specific varieties for climate change resilience

Theory

In vitro culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micrografting, somocloning and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites. Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide

hybridization, embryo rescue of recalcitrant species, *invitro* conservation. *Invitro* mutation for biotic and abiotic stresses recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology. Quality improvement, improvement for biotic and abiotic stresses transgenic plants. Role of molecular markers in characterization of transgenic crops, finger printing of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology with special reference to Tomato, eggplant, hot and sweetpepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

Practical

Establishment of axenic explants, callus initiation and multiplication, production of suspension culture, cell and protoplast culture, fusion, regeneration and identification of somatic hybrids and cybrids; Identification of embryonic and non-embryonic calli, development of cell lines; *in vitro* mutant selection for biotic and abiotic stresses, *In vitro* production and characterization of secondary metabolites, isolated microspore culture, isolation and amplification of DNA, gene transfer methods, molecular characterization of transgenic plants.

References

1. Bajaj, Y. P. S. (Ed.). (1987). *Biotechnology in agriculture and forestry*. Vol. XIX. *Hitech and Micropropagation*. Springer.
2. Chadha, K. L., Ravindran, P. N and Sahijram, L. (Eds.). (2000). *Biotechnology of horticulture and plantation crops*. Malhotra Publishing House
3. Debnath, M. (2005). *Tools and techniques of biotechnology*. Pointer Publishers
4. Glover, M. D. (1984). *Gene Cloning: The mechanics of DNA manipulation*. Chapman & Hall
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11. Prasad, S. (1999). *Impact of plant biotechnology on horticulture*. 2nd Ed. Agro Botanica
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13. Singh, B. D. (2001). *Biotechnology*. Kalyani Publishers
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16. Williamson, R. (1981-86). *Genetic Engineering*. Vols. I-V

21HO3158 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS

Credits: 2 (1+1)

Course Objectives:

To impart knowledge on

1. Recent trends in the seed certification, processing and storage of vegetable crops
2. Advances in physiological and biochemical process of seed aging
3. The techniques of seed production, seed treatment and packing

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the recent trends in seed production technology of major vegetable crops
2. Recent trends in research on seed deterioration
3. Enumerate the procedures for seed certification
4. Demonstrate the techniques of seed treatment and advances in research
5. Discuss the role of new seed policy and seed industry and farmers
6. Elucidate the measures for seed quality enhancement in vegetables

Theory

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification. Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number. Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control. Seed testing; ISTA rules for

testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy. Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy. (With specific reference /examples of cucurbits, solanaceous, leguminous, cruciferous, bulb, root, leaf and tuber crops)

Practical

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

References

1. Agrawal, P. K. and Dadlani, M. (1992). *Techniques in seed science and technology*. South Asian Publishers
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21HO3171 ADVANCES IN FLOWER PRODUCTION TECHNOLOGY

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Latest developments in production technology of flower crops
2. Latest trends in production technology of flower crops
3. Advanced cultivation techniques of flower crops

Course Outcomes:

On completion of this course, students will be able to

1. Explain the global scenario of cut flower production and trade
2. Demonstrate the advanced propagation techniques of cut flower crops
3. Outline the irrigation and fertilizer requirement for cut flower crops
4. Discuss the environmental parameters using advanced techniques
5. Cultivate cut flower crops under protected structures
6. Describe the techniques for year-round flowering of cut flower crops

Theory

Commercial flower production; Scope and importance; Global Scenario in cut flower production and trade, varietal wealth and diversity; Soil and environment; Special characteristics and requirements; cut flower, loose flowers, dry flowers and floral oil trade. Propagation and multiplication; IPR issues related to propagation of materials; Greenhouse management; Soil/media decontamination techniques; Micro irrigation; nutrition and fertigation; slow-release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering; regulation for quality flowers. Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation; Harvest indices; Harvesting techniques; post-harvest handling; Precooling, pulsing, packing, marketing; Export potential; Agri Export Zones. Crop specific practices – Rose, anthurium, orchids, carnation, gladioli, gerbera, lilies, heliconia, bird of paradise, *Jasminum* sp., marigold, tuberose, crossandra. Floral oil industry, floral concrete production, extraction methods, recent advances.

Practical

Varietal wealth in flower crops; Greenhouse management; Soil decontamination techniques; Micro irrigation; Nutrition and fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Assessing harvest indices; post-harvest handling; Tissue analysis; Preparation of floral decorative; Extraction of floral concrete and oils; Case studies; Visit to commercial cut flower units.

References

1. Bose, T. K., Maiti, R. G., Dhua, R. S and Das, P. 1999. *Floriculture and Landscaping*. Naya Prokash.
2. Chadha, K. L and Choudhury, B. 1992. *Ornamental Horticulture in India*. ICAR.
3. George, S and Peter, K. V. 2008. *Plants in a garden*. New India Publishing Agency.
4. Lauria, A and Victor, H. R. 2001. *Floriculture – Fundamentals and Practices*. Agrobios

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6. Reddy, S., Janakiram, B., Balaji, T., Kulkarni, S and Misra, R. L. 2007. *High Tech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi

21HO3172 ADVANCES IN PROTECTED AND PRECISION FLORICULTURE

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Protected cultivation of flower crops
2. Precision farming system of flower crops
3. Precision equipment's, computers and robotics in precision farming

Course Outcomes:

On completion of this course, students will be able to

1. Explain the prospects of protected floriculture in India
2. Describe the environmental control systems in green house
3. Explain the importance of GPS, GIS in precision floriculture
4. Discuss the environmental parameters using advanced techniques
5. Explain the flower crops cultivation under precision farming system
6. Demonstrate the post-harvest management techniques in flower crops

Theory

Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance. Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques.

Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, lilies, cut foliage; Harvest indices viz., harvesting, post-harvest handling, marketing, export. Precision floriculture, principles and concepts, enabling technologies of precision farming, GPS, GIS, remote sensing, sensors. Variability management in precision farming, mapping, variable rate technology, precision equipment's, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Practical

Growing structures, basic considerations in establishment and operation of greenhouses, environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques, crop regulation, special horticultural practices under protected cultivation, precision equipment's, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

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21HO3173 ADVANCES IN BREEDING OF FLOWER CROPS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Advanced hybridization techniques in breeding of flower crops
2. Breeding achievements in crop improvement of flower crops
3. The recent research trends in the field of breeding of flower crops

Course Outcomes:

On completion of this course, students will be able to

1. Frame the breeding objectives for flower crops
2. Demonstrate the *in-vitro* breeding of flower crops
3. Explain the genetic mechanisms of flower crops
4. Develop breeding strategies for biotic stress management in flower crops
5. Outline breeding strategies for abiotic stress management in flower crops
6. Explain the incompatibility mechanisms of flower crops

Theory

Origin and evolution of varieties, distribution, genetic resources, genetic divergence, plant introduction, selection and domestication, inheritance of important characters, genetic mechanisms associated with flower color and flower size, doubleness, fragrance and post-harvest life, Plant Variety Protection Act. Specific objectives of

breeding in flower crops, methods of breeding suited to seed and vegetatively propagated flower crops, introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, exploitation of heterosis, utilization of male Sterility-Incompatibility problems, *in-vitro* breeding. Breeding for resistance to pests, diseases, nematodes and other biotic and abiotic stresses in flower crops. Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, gerbera, gladioli, orchids and anthurium. Specific breeding problems and achievements made in aster, petunia, lilliums, heliconia, bird of paradise, hibiscus and bougainvillea.

Practical

Description of crops and cultivars; Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies; Induction of mutants; Physical and chemical mutagens; Induction of polyploidy; Screening of plants for biotic and abiotic stresses and environmental pollution; *in-vitro* breeding in flower crops.

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4. Singh, B. D. (1990). *Plant breeding*. Kalyani Publishers

21HO3174 ADVANCES IN LANDSCAPE ARCHITECTURE

Credits: 3(1+2)

Course Objectives:

To impart knowledge on

1. Recent trends in the field of landscape architecture
2. Developing practical skills in the field of landscape architecture
3. Environmental landscaping techniques

Course Outcomes:

On completion of this course, students will be able to

1. Design the different garden styles
2. Create a plan for lawn making
3. Demonstrate water scaping, hardscaping, etc.,
4. Explain the environmental control systems in greenhouse
5. Discuss the techniques involved in playground landscaping
6. Estimate the cost for the landscaping project.

Theory

Commercial landscape gardening: History, plant identification and ecology, Materials of garden design, design making by different garden styles and types. Expenses to model landscaping units of all category, creativity and communication skills for landscape architect, Way of designing a commercial landscape project. Assessing site and plants adaptability for different locations, landscape engineering (Topographical) survey and designing concept), special techniques in garden landscaping (Burlapping, water scaping, hardscaping, lawn making, topiary styles specializing, bio aesthetic planning). Preparation and drawing of site plan, learning the basics in computer aided design (CAD) for developing a garden landscape plan, handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing. Contemporary landscaping, environmental landscaping, industrial and institutional landscaping, Public and private garden making, playground landscaping, case study with the successful landscapist, budget / project cost estimating, execution strategies, assessing a successful design in site.

Practical

Commercial landscaping, plant identification, materials of garden design, design making by different garden styles and types. Way of designing a commercial landscape project, visit to model ornamental nursery. Assessing site and plants adaptability for different locations, landscape engineering (Topographical survey and designing concept), special techniques in garden landscaping (Burlapping, water scaping, hardscaping, lawn making, topiary styles specializing, bio aesthetic planning). Preparation and drawing of site plan, learning the basics in computer aided design (CAD) for developing a garden landscape plan, handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing. Contemporary landscaping, environmental landscaping, industrial and institutional landscaping, public and private garden making, playground landscaping, case study with the successful landscapist, budget/project cost estimating, execution.

References

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21HO3175 ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Advances in biochemistry of flowers
2. Application of biotechnology in flower crops
3. *In vitro* lines for biotic and abiotic stress management in flower crops

Course Outcomes:

On completion of this course, students will be able to

1. Explain the biochemistry of flower crops
2. Discuss bio colours and their value addition
3. Describe the *in vitro* lines for biotic and abiotic stress management in flower crops
4. Demonstrate water scaping, hardscaping, etc.,
5. Explain the somoclonal variation and its applications
6. Discuss the gene cloning, genetic engineering

Theory

Biochemistry of flowers: Principle involved in the formation of pigments viz., chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins. Chemistry and importance of secondary metabolites in rose, jasmine, marigold, tuberose, carnation, orchids, lilliums and bougainvillea. Biochemistry and utilization commercial products (select items). Recent trends viz., Extraction of bio colours and their value addition, uses in food and textile industries. Biochemistry of post-harvest management of cut flowers. Biotechnology viz., tools techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cytodifferentiation, organogenesis, somatic embryogenesis. *In vitro* lines for biotic and abiotic stress viz., Meristem culture for disease elimination, production of haploids through anther and pollen culture viz., embryo and ovule culture, micrografting, wide hybridization and embryo rescue techniques, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, *in vitro* pollination and fertilization, hardening media, techniques and establishment of tissue culture plants in the primary and secondary nursery.

Somoclonal variation and its applications – variability induction through *in vitro* mutation, development of cell suspension cultures, types and techniques, *in vitro* production of secondary metabolites, role of bioreactors in production of secondary metabolites, quantification and quality analysis of secondary metabolites using HPLC, *in vitro* conservation and cryo-preservation techniques. Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, *Agrobacterium* mediated, transgenic plants in flower crops, medicinal and aromatic crops, isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE & PAGE techniques; identification of molecular markers. Construction of c- DNA library, DNA fingerprinting technique in economic flower crop varieties, molecular approaches to control ethylene response, improving shelf life, improving resistance for environmental stress, approaches to improve flower development, pigment production, secondary metabolite production, post-harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.

Practical

Extraction of flower pigments viz., xanthophylls, carotenoids and anthocyanins. Plant nutrient stock, growth regulators, media preparation and sterilization viz., *in-vitro* seed germination, callus culture and organ culture- Cell suspension culture viz., cell plating and regeneration, clonal propagation through meristem culture, induction of multiple shoots, anther, pollen- ovule and embryo culture, synthetic seed production, *in-vitro* mutation induction, *in vitro* rooting, hardening at primary and secondary nurseries, Project preparation for establishment of low, medium and high cost tissue culture laboratories, DNA isolation from economic flower crop varieties, quantification and amplification, DNA and protein profiling, molecular markers for economic flower crops, restriction enzymes, vectors for cloning and particle bombardment, DNA fingerprinting of flower crop varieties.

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21HO3188 ADVANCES IN PRODUCTION OF PLANTATION CROPS

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Importance and export potential of plantation crops grown in India
2. Advanced production technology of plantation crops grown in India
3. Varietal wealth of plantation crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe the export potential of plantation crops
2. Describe the important varieties of plantation crops
3. Demonstrate the propagation methods in plantation crops
4. Explain about the advanced production technology of plantation crops
5. Describe the advanced post-harvest practices and value addition in plantation crops
6. Outline the GAP, GMP and HACCP practices in important plantation crops

Theory

Plantation crops – area and production, export potential - varietal wealth and appraisal on the crop improvement in plantation crops. Mass multiplication techniques, high density planting, systems of cultivation, multitier cropping, companion cropping, studies of on canopy and root management, photosynthetic efficiencies of crops at different tiers, biotic and abiotic factors on growth and productivity, nutritional requirements, role of macro and micro nutrients, nutrient deficiency symptoms, growth regulators, water requirement, fertigation, soil and moisture conservation practices, drought management, permanent vegetation management, basin management, training and pruning, maturity indices, harvesting, curing, processing and value addition, grading, packing and storage, role of commodity boards in plantation crop development, production of plantation crops through GAP, GMP, HACCP in coffee, tea, cashew, cocoa, rubber, palmyrah, oil palm, coconut, arecanut, wattle and betelvine.

Practical

Description of botanical and varietal features-selection of mother palms and elite clones, Clonal fidelity testing, nursery techniques and propagation methods, high density planting, training and pruning practices, fertigation and foliar nutrition, shade regulation, maturity standards, harvesting, curing, processing and grading, project preparation for establishing new plantations, visit to plantation gardens, commodity boards and plantation-based industries.

References

1. Anonymous (1985). *Rubber and its cultivation*. The Rubber Board of India
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21HO3189 ADVANCES IN SPICE PRODUCTION

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Importance and export potential of plantation crops grown in India

2. Advanced production technology of plantation crops grown in India
3. Varietal wealth of plantation crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe the importance and global scenario of spice crops
2. Discuss the important varieties of spice crops
3. Demonstrate the nursery management practices in spice crops
4. Explain about the advanced production technology of spice crops
5. Describe the advanced post-harvest practices and value addition in spice crops
6. Discuss the GAP and GMP practices in important spice crops

Theory

Spices- current status on area and production, state, national and global scenario of spices, global trade, problems encountered in spices productivity, systems of cultivation, varieties, soil and climate, propagation techniques and nursery management, planting systems and methods, cropping pattern, permanent floor management concepts in mulching and weed management, canopy and root studies under different spice-based cropping systems, shade and basin management, INM practices, irrigation and fertigation techniques, chemical regulation of crop productivity, IPM, clean cultivation strategies, harvesting, post-harvest and quality management for value added spices, quality standards, GAP and GMP for spices production, quality control and certification. Protected cultivation of high value spice crops. Value addition and by-product utilization. Precision farming and organic farming in spice crops such as pepper, cardamom, nutmeg, clove, cinnamon, allspice, turmeric, ginger, garcinia, tamarind, garlic, coriander, fenugreek, fennel, cumin, vanilla, paprika and important herbal plants. Commodity Boards in spices development

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term experiments on spice crops.

References

1. Chadha, K. L. (2001). *Hand book of horticulture*. ICAR
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21HO3190 ADVANCES IN MEDICINAL AND AROMATIC CROP PRODUCTION TECHNOLOGY

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Genetic diversity and importance of medicinal and aromatic crops grown in India
2. Production and post-harvest technology of medicinal and aromatic crops grown in India
3. Varietal wealth of medicinal and aromatic crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe the importance and conservation of medicinal and aromatic crops
2. Explain about the advanced research methods in medicinal and aromatic crops
3. Describe about the important varieties of medicinal and aromatic crops
4. Explain about the production technology of medicinal and aromatic crops
5. Describe the harvesting and post-harvest practices in medicinal and aromatic crops
6. Discuss the GAP, GCP and GMP practices in medicinal and aromatic crops

Theory

Genetic biodiversity of medicinal plants, conservation networks, global initiatives on medicinal plants conservation and development, World history on usage of medicinal plants, Preference to natural products, Advanced research in biomedicines, Nutraceuticals and natural drugs, American, European and Asian legislations on plant drugs, Intellectual Property Rights, Patents. Indian traditional wisdom and Heritage- Indian herbal wealth, documentations, databases, scientific validation, production problems of medicinal and aromatic plants, export and import status. WTO scenario - Principles and guidelines for GAP, GCP and GMP in medicinal crops. Climate,

soil and substrate culture, improved varieties, organic production, nutrition and irrigation requirements, inter culture, mulching, weed control, maturity indices and harvesting, post-harvest handling, drying, processing, grading, packing and storage, quality standards in medicinal plants, biotechnological approaches for advances in phytochemical extraction technologies, separation of bio-molecules, distillation methods, essential oil extraction and value addition in aromatic plants, phytochemicals and drug development. Medicinal crops: *Coleus forskohlii*, glory lily, senna, periwinkle, *Stevia rebaudiana*, aswagandha, sarpagandha, *Aloe vera*, *Dioscorea* sp, *Phyllanthus amarus*, *Andrographis paniculata*, medicinal solanum, isabgol, *poppy*, *Digitalis* sp, *Commiphora* sp, *ipecac*, *henbane*, *Ocimum* sp., *centella*, *bacopa*, *Saraca indica* and *bael*. Aromatic crops: Palmarosa, lemongrass, citronella, vetiver, geranium, artemisia, mentha, *ocimum*, eucalyptus, rosemary, thyme, patchouli.

Practical

Identification and documentation- propagation in medicinal crops, maturity standards, harvesting and drying techniques, processing and grading, analysis of bio-molecules, extraction of secondary metabolites, identification and characterization of secondary metabolites, essential oils, visit to commercial medicinal plants field, visit to GMP phytochemical extraction and value addition unit.

References

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2. Farooqi, A. A., Khan, M. M and Vasundhara, M. (2001). *Production technology of medicinal and aromatic crops*. Natural Remedies Pvt. Ltd
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21HO3191 ADVANCES IN BREEDING OF PLANTATION CROPS AND SPICES

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. The principles and advances in breeding of plantation crops
2. The principles and advances in breeding of spice crops
3. Biotechnological approaches in breeding of plantation and spice crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe about the species and cultivars of plantation and spice crops
2. Explain about the pollination and fertilization mechanisms in plantation and spice crops
3. Describe the approaches for crop improvement in plantation and spice crops
4. Explain about the different advancements in breeding of plantation crops
5. Explain about the different advancements in breeding of spice crops
6. Explain the biotechnological approaches in improvement of plantation and spice crops

Theory

Evolutionary mechanisms, adaptation and domestication, genetic resources, genetic divergence, cytogenetics, variations and natural selection, types of pollination and fertilization mechanisms, sterility and incompatibility system, recent advances in crop improvement efforts, introduction and selection, chimeras, clonal selections, intergeneric, interspecific and intervarietal hybridization, heterosis breeding, mutation and polyploidy breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, genetics of important traits and their inheritance pattern, molecular and transgenic approaches and other biotechnological tools in improvement of selected spice and plantation crops in coffee, tea, cashew and cocoa, rubber, palmyrah and oil palm, coconut, arecanut, black pepper and cardamom, nutmeg, clove, cinnamon, allspice, turmeric, ginger, garcinia, tamarind, garlic, coriander, fenugreek, fennel, cumin and vanilla.

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination, survey and clonal selection, screening techniques for abiotic stresses, screening and rating for pest, disease and stress resistance in inbreds and hybrids, estimation of quality and processing characters for quality improvement, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding and *in vitro* breeding techniques.

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21HO3192 ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. The principles and advances in breeding of medicinal crops
2. The principles and advances in breeding of aromatic crops
3. Biotechnological approaches in breeding of medicinal and aromatic crops

Course Outcomes:

On completion of this course, students will be able to

1. Describe about the species and cultivars of medicinal and aromatic crops
2. Discuss about the genetic mechanism associated with secondary metabolites in medicinal and aromatic crops
3. Describe the approaches for crop improvement in medicinal and aromatic crops
4. Explain about the advances in breeding of medicinal and aromatic crops
5. Explain about the biotechnological approaches in improvement of medicinal and aromatic crops
6. Explain about the specific breeding objectives in medicinal and aromatic crops

Theory

Origin and evolution of varieties, distribution- Genetic resources, genetic divergence, plant introduction, selection and domestication - Inheritance of important characters, genetic mechanisms associated with alkaloids and secondary metabolites. Methods of breeding suited to seed and vegetative propagated crops. Polyploidy and mutation breeding in the evolution of new varieties, exploitation of heterosis, utilization of male sterility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops. Specific breeding objectives in medicinal and aromatic crops, genetic bio diversity, breeding problems and improvements in senna, periwinkle, aswagandha, isabgol, sarpagandha, poppy, glory lily, *coleus*, *mucuna* and *ocimum*, centella, bacopa, dioscorea, solanum, andrographis, *aloevera*, phyllanthus, eucalyptus, bael, cinchona. Specific breeding objectives in medicinal and aromatic crops, genetic bio diversity, breeding problems and improvements in Henbane aromatic grasses, geranium, patchouli, artemisia, rosemary, thyme, sage, marjoram, fever few. Biotechnological approaches for crop improvement of medicinal and aromatic crops

Practical

Description of crops and cultivars, cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies, induction of economic, colour mutants, increased alkaloid content in medicinal crops, high essential oil content in aromatic plants, physical and chemical mutagens, induction of polyploidy, screening of plants for biotic and abiotic stresses and environmental pollution, *in-vitro* breeding in flower crops, medicinal and aromatic crops.

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21HO3206 PHYSIOLOGY OF RIPENING AND SENESCENCE

Credits: 2 (1+1)

Course Objectives:

To impart knowledge on

1. Environmental factors that control the ripening and senescence
2. Molecular and physiological mechanisms of senescence and ripening
3. Approaches to manipulate ethylene biosynthetic pathway

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the internal factor and external factors that cause senescence and ripening
2. Elucidate the molecular mechanism of senescence and ripening
3. Enumerate the structural changes of cell during senescence and ripening
4. Describe the biosynthetic pathway of ethylene
5. Explain the physiological and biochemical changes take place during senescence and ripening
6. Describe the involvement of many types of enzymes during ripening of fruits

Theory

Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening. Senescence associated genes. Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening. Ethylene biosynthesis, perception and molecular mechanism of action; regulatory role of ethylene in senescence and ripening. Approaches to manipulate ethylene biosynthesis and action. Alternate postharvest methodology and quality attributes. Scope for genetic modification of post-harvest life of horticultural crops.

Practical

Physiological and biochemical changes during ripening and senescence, estimation of ethylene during ripening and senescence, determination of reactive oxygen species and scavenging enzymes, measurement of dark and alternate respiration rates during ripening and senescence. Estimation of ripening related enzyme activity, cellulases, pectin methyl esterases, polygalacturonase, regulation of ripening etc.

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21HO3207 NOVEL PROCESSING TECHNOLOGIES FOR HORTICULTURAL PRODUCE

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Recent advances made in the food processing industries
2. Functional food and nutraceuticals
3. Role of microbes in the food industry

Course Outcomes:**On completion of this course, students will be able to**

1. Elaborate the minimal processing concept of food
2. Enumerate the role of recent methods of food processing
3. Explain the benefits and advantages of making functional food and nutraceuticals
4. Enumerate the importance of genetically engineered microbes in food industry
5. Develop innovative methods of fortification of food
6. Acquire the skills on freeze preservation

Theory

Recent advances in processing technologies: Aseptic processing, individual quick freezing and cryogenic freezing, membrane technology, extrusion cooking, vacuum frying, ohmic heating, microwave processing and dielectric heating. Non thermal processing -Irradiation, pulsed electric field, magnetic fields, pulsed light treatment, high pressure processing, ultrasound, linear induction electron accelerator (LIEA), SCFE, ozonation, minimal processing and hurdle technology. Functional foods and nutraceuticals, enzymes and their application in food industry. Principles of food biotechnology, genetic modification of microorganisms in food industry (lactic acid bacteria, yeasts and moulds), production of high valued food products viz., enzymes, organic acids, SCP, nutritional additives, flavours, pigments

Practical

Methods of food fortification. Determination of thermal resistance of bacteria TDT and TDP. Determination of thermal death curve. Thermal process calculations. Study of problems associated with new technologies. Group discussions. Advances in fermentation technology. Recent trends in freeze preservation. Development of new products and value addition. Visit to processing industries.

References

1. Barbosa-Canovas. (2002). *Novel food processing technologies*. CRC. Press
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3. Da-Wen Sun. (2006). *Thermal food processing: new technologies and quality issues*. CRC/Taylor and Francis
4. Gould, G. W. (2000). *New methods of food preservation*. CRC. Springer Science
5. Philip R., (2001). *Thermal technologies in food processing*. CRC Press
6. Ramaswamy, H and Marcotte, M., (2006). *Food Processing: Principles and applications*. Taylor and Francis
7. Rajarathnam, S and Ramteke, R. S. (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA publishers

21HO3208 ADVANCES IN LABORATORY TECHNIQUES IN POST-HARVEST TECHNOLOGY**Credits: 3 (1+2)****Course Objectives:****To impart knowledge on**

1. Principles of food quality assurance
2. Food grade, food laws and food standards
3. Advanced techniques of food analysis

Course Outcomes:**On completion of this course, students will be able to**

1. Explain the techniques for food analysis
2. Differentiate the browning reactions from non-browning reaction
3. Analyze the different kinds of food additives
4. Demonstrate the non-destructive quality evaluation of food
5. Analyze the food through different types of Chromatographic techniques
6. Elucidate the residual analysis of food

Theory

Importance of quality of processed foods. Principles of food quality assurance. Introduction to quality evaluation. Food grades, standards, laws and regulations. Sampling procedure for food analysis. Advances in techniques of food analysis for carbohydrates, organic acids, vitamins, polyphenols, flavonoids, minerals, anthocyanins, enzymes; Rheological techniques and instrumentation used in food industry. Determination of browning and associated reactions in processed foods and their implications. Analysis of food additives like food colour, antioxidants, emulsifier, etc. Analysis of pesticide residues, metallic contaminants, aflatoxin. Analysis of food flavours. Quality analysis of processed fruits and vegetables, coffee, tea and spices. Identification and enumeration of microbial contaminants. Principles of chromatography (GC, GCMS, HPLC, LCMS), spectrophotometry (Atomic absorption spectrophotometer, ICAP spectrophotometer), ICP-MS, ICPOES, NMR, ESR, amino acid

analyser, flame photometry, electrophoresis, colour measurement in foods, IRGA, radioisotopic techniques. Nondestructive quality evaluation (NDQE)- E-nose E-tongue, machine vision. Electrophoresis. Sample preparation for quality analysis. Energy calculation, sample calculations. Texture analysis. Rheology of different foods. Instrumental colour analysis. Sensory evaluation and microbiological examinations of fresh and processed products; Estimation of tannin/phytic acid by spectrometric method; moisture and fat analysis by NIR spectroscopy; Separation and identification of sugars in fruit juices; Separation and identification of carotenoids by column chromatography; Estimation of respiration in fruits and vegetables, flavor profile in essential oils using GC; Identification and determination of organic acids by HPLC; capsaicin content and Scoville Heat Units in chillies; Heavy metal analysis using atomic absorption spectrometry; Residue analysis.

Practical

Sampling procedure for food analysis, Determination of browning and associated reactions in processed foods. Analysis of food additives like food colour, antioxidants, emulsifier. Analysis of pesticide residues, metallic contaminants, aflatoxin. Analysis of food flavours. Quality analysis of processed fruits and vegetables. Identification and enumeration of microbial contaminants. Principles of chromatography (GC, GCMS, HPLC, LCMS), spectrophotometry (Atomic absorption spectrophotometer, ICAP spectrophotometer), ICP-MS, ICPOES, NMR, ESR, amino acid analyser, flame photometry, electrophoresis, colour measurement in foods, IRGA, radioisotopic techniques. Estimation of tannin/phytic acid by spectrometric method; moisture and fat analysis by NIR spectroscopy. Identification and determination of organic acids by HPLC; Estimation of respiration in fruits and vegetables, flavor profile in essential oils using GC.

References

1. AOAC International. (2003). *Official methods of analysis of AOAC International*. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities. AVI Publishers
2. Leenheer, A. P., Lambert, W. E and Bocxlaer, J. F. (2000). *Modern chromatographic analysis of vitamins*. 3rd Ed. Marcel Dekker
3. Maslowitz, H. (2000). *Applied sensory analysis of food*. Vol. I & II. CRC Press
4. Ranganna, S. (2001). *Handbook of analysis and quality control for fruit and vegetable products*. 2nd Ed. Tata-McGraw-Hill
5. Taylor, A. (2002). *Food flavour technology*. Sheffield Academic Press
6. Rajarathnam, S and Ramteke, R. S. (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA publishers

21HO3209 ADVANCES IN PACKAGING TECHNOLOGY OF HORTICULTURAL PRODUCE

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. Recent methods of packaging of horticultural produce
2. Role of different packing materials
3. Recycling of packing materials

Course Outcomes:

On completion of this course, students will be able to

1. Apply advanced packaging technology for better quality of the horticulture produce
2. Enumerate the advantages of NMBP over to the conventional packaging materials
3. Describe the packaging and flavor interaction
4. Enumerate the time temperature indicators and maximizing its effectiveness
5. Design the packaging materials for predicting shelf life of horticultural produce
6. Evaluate the pesticide migration from packaging material to food

Theory

Active packaging techniques, intelligent packaging techniques, novel packaging techniques, oxygen scavenging technology, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging: Development of antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging. Non-Migratory Bioactive Polymers (NMBP) in food packaging, advantages of NMBP, limitations, inherently bioactive synthetic polymers: types and applications. Polymers with immobilized bioactive compounds. Time-temperature indicators (TTIs), Defining and classifying TTIs, Requirements for TTIs. The development of TTIs, Current TTI systems, maximizing the effectiveness of TTIs, using TTIs to monitor shelf-life during distribution, Using TTIs to optimize distribution and stock rotation. Packaging-Flavour interactions, factors affecting flavor absorption, role of the food matrix, role of differing packaging materials, Case study: Packaging and lipid oxidation, Modeling flavour absorption, Packaging-Flavour interactions and active packaging, Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O₂ MAP. Recycling of packaging materials

Practical

Identification of plastic film material - Specific gravity test, melting and odour test, burning test, solubility test. General quality control. Tests carried out on papers, plastic films, foils and multilayered films - Chloride test, pH test, moisture content, tensile test, bursting test, tearing resistance, puncture and other impact tests, insect penetration test, heat sealing strength, toxicity test, colour migration test. Testing of lacquered tin plate sheets; Measurement of tin coating weight by Clarke's method. Determination of GTR and WVTR in different packaging materials, use of oxygen and ethylene scavengers in packaging of fresh fruits, application of anti-microbial packaging for moisture sensitive foods, evaluation of pesticide residue migration from package to food, application of MAP and active packaging in selected foods, determination of oxidative changes in packaged foods, comparative evaluation of flexible and rigid packages for fragile foods, packaging of foods under inert atmosphere. Prediction of shelf life of foods, selection and design of packaging material for different foods

References

1. Ahvenainen, R. (2001). *Novel food packaging techniques*. CRC.
2. Rajarathnam, S and Ramteke, R. S. (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA publishers.

21HO3210 STORAGE TECHNIQUES AND SUPPLY/COLD CHAIN MANAGEMENT OF HORTICULTURAL PRODUCE

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Recent methods of storage of horticulture produce
2. Functional food and nutraceuticals
3. Supply chain management of horticulture produce

Course Outcomes:

On completion of this course, students will be able to

1. Apply cold chain technology to enhance the shelf life of horticultural produce
2. Enumerate the role of modern methods of food storage
3. Explain the importance of supply chain management of food
4. Enumerate the importance of e-marketing strategies of horticultural produce
5. Develop innovative and low-cost methods for storage of food
6. Demonstrate various models in decision making

Theory

Controlled atmosphere, modified atmosphere, hypobaric storage, cold storage. Building blocks of supply chain network, performance measures, decisions in supply world and models. Supply chain inventory management. Use of stochastic models and combinatorial optimization in supply chain planning, layout, capacity planning, inventory optimization, dynamic routing and scheduling. Internet technologies and electronic commerce in supply chain management related to enterprise resource planning, Q procurement, logistics, internet auctions, e-market and business process optimization. Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration. Products going in cold chain, their temperature and humidity requirements, packaging needs and their compatibility in cold chain. Stages and points of control in cold storages and structures, functions in cold storages, pallet layout and stacking options, flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems. Temperature recording devices used during transport, documentation and traceability, risk management problem diagnosis, cost benefit studies for type of transport, loading and unloading, storage duration.

Practical

Problems and case studies related to storage techniques and SCM, demonstration of various models in decision making, case studies for SCM in processing of fruits/vegetable, case study for export of one perishable and one nonperishable food, visit to various retail outlets and export-oriented units.

References

1. Chattopadhyaya, S. K. (2007). *Handling, transportation and storage of fruits and vegetables*. Gene-Tech books, New Delhi
2. Chopra, S and Meindel, P. (2002). *Supply chain management: Strategy, planning and operation*. Prentice Hall
3. Levi, D. S., Kaminsky, P and Levi, E. S., (2000). *Designing and managing the supply chain: Concepts, strategies and case studies*. Mc Graw Hill
4. Shapiro, J. F. (2001). *Modeling the supply chain*. Duxbury Thomson Learning.
5. Viswanadham, N. (2000). *Analysis of manufacturing enterprises*. Kluwer

6. Rajarathnam, S and Ramteke, R. S., (2011). *Advances in preservation and processing technology of fruits and vegetables*. By NIPA publishers

21AG3214 PLANT BIOCHEMISTRY

Credits 3 (2+1)

Course Objectives:

To impart knowledge on

1. Biochemical basis of various plant processes
2. Molecular basis of various plant processes
3. Biochemistry of secondary metabolites

Course Outcomes:

On completion of this course, students will be able to:

1. Understand the biochemistry of plant photosynthesis
2. Remember the biosynthesis of plant biomolecules
3. Understand the biochemistry of plant developmental processes
4. Explain the biochemistry of stress mechanisms in plant system
5. Describe the synthesis of secondary metabolites in plant system
6. Discuss defense mechanisms in plant system

Theory

Scope and importance of biochemistry in Agriculture, Plant cell organelles - structure and function. Photosynthetic pigments in relation to their functions, photosynthesis, C3, C4 and CAM pathways, photorespiration. Sucrose-starch interconversion, Biosynthesis of structural and storage carbohydrates, storage proteins and lipids. Biochemistry of nitrogen fixation and nitrate assimilation, sulphate reduction and incorporation of sulphur into amino acids. Biochemistry of seed germination and fruit ripening. Phytohormones and their mode of action. Stress biochemistry - ROS, Enzymic and non-enzymic antioxidants, abiotic stresses, Osmoprotectants - glycine-betaine, proline, polyamines; Heat shock proteins - Biosynthesis and mechanism of action. Signal transduction. Biochemistry and significance of secondary metabolites - Shikimate pathway, phenolic compounds, terpenoids, alkaloids, cyanogenic glycosides, glucosinolates, Plant defense system- PR proteins, phytoalexins, cinnamic acid, salicylates, jasmonic acid, toxic amino acids - mode of action.

Practical

Estimation of total sugars, starch by anthrone method, amylose, proteins by Lowry's method, peroxide value, total free amino acids, proline, alkaloids, total phenols, tannins, flavonoids, estimation and extraction of lycopene and carotenoids, Determination of IAA, Enzyme extraction methods - Assay of catalase, peroxidase and polyphenol oxidase.

References

1. Buchanan, B., Gruissem, W and Jones, R. (2002). *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.
2. Goodwin, T.W and Mercer, E.I. (2003). *Introduction to Plant Biochemistry*. CBS.
3. Keshavachandran, R and Peter, K. V. (2008). *Plant Biotechnology: Methods in Tissue Culture and Gene Transfer*. Orient and Longman (Universal Press).

21AG3215 PRINCIPLES OF PLANT PHYSIOLOGY

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Concepts of plant physiology
2. Application of physiological concepts in agriculture
3. The role of plant growth regulators on plant growth

Course Outcomes:

On completion of this course, students will be able to

1. Explain about the physiological functions of cell organelles.
2. Discuss about the relationship between soil, water and plant.
3. Explain about the stomatal function, transpiration and water stress in plants.
4. Describe the role of various growth regulators on plant growth.
5. Describe about the photosynthesis and photorespiration.
6. Explain about the physiology of flowering and plant movements.

Theory

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions. Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells. Mechanism of

water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorrhizal association on water uptake. Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level-evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate. Stomata structure and function – mechanism of stomatal movement, anti-transpirants. Physiology of water stress in plants: Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance. The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants. Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants. Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition.

Photorespiration and its relevance. Photosynthesis as a diffusive process and effect of environmental factors on photosynthetic rates. Photosynthesis and translocation of photosynthates and its importance in bio productivity. Photochemical process, photochemical reactions, CO₂ reduction in Calvin cycle, supplementary pathway of C fixation in C₄ and CAM plants and its significance. Impact of climate change on photosynthesis. Photorespiration and its relevance. Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance. Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominance, senescence, fruit growth, development, ripening and abscission. Photo morphogenesis: Photoreceptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation. Classification of Plant Movements. Physiology of Plant Movements – nastic and tropic movements.

Practical

Measurement of soil water status: Theory and principle of pressure plate apparatus, neutron probe, Measurement of plant water status: Relative water content, water saturation deficits Chardakov's test. Theory and principle of pressure bomb, psychrometer and osmometer, Measurement of transpiration rate. Measurement of vapour pressure deficits, theory and principle of porometry, diffusion porometer and Steady state porometer, Stomatal physiology, influence of ABA on stomatal closing. Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency symptoms of nutrients, Radiant energy measurements, separation and quantification of chlorophylls, O₂ evolution during photosynthesis, Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

References

1. Hopkins, W.G. and Huner, N.P.A. (2004). *Introduction to Plant Physiology*. John Wiley & Sons.
2. Salisbury, F.B. and Ross, C. (1992). *Plant Physiology*. 4th Ed. Wadsworth Publishers.
3. Taiz, L and Zeiger, E. (2006). *Plant Physiology*. 4th Ed. Sinauer Associates.

21AG3216 SOIL FERTILITY AND FERTILIZER USE

Credits 3 (2+1)

Course Objectives:

To impart knowledge on

1. The basic principles of soil fertility and productivity.
2. The major fertilizer sources and its management.
3. The soil test methods for fertilizer recommendations.

Course Outcomes:

On completion of this course, students will be able to

1. Discuss on the basic concepts of soil fertility and productivity.
2. Describe the essential plant nutrients.
3. Discuss on the major fertilizer sources and its management.
4. Outline on the common soil test methods for fertilizer recommendations.
5. Overview on the fertilizer use efficiency.
6. Outline on the fertilizer recommendations and its various approaches.

Theory

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency. Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

Calcium and Magnesium– factors affecting their availability in soils; Calcium and Magnesium fertilizers. Sulphur - source, forms, fertilizers and their behavior in soils; management of sulphur, Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability. Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions. Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture. Fertilizer use efficiency; Fertilizer recommendations-various approaches – blanket, site-specific nutrient management (SSNM); Soil Test Crop Response –Integrated Plant Nutrition System (STCR-IPNS), Critical level approach, Mitscherlich-Bray - usefulness and limitations

Practical

Principles of colorimetry - flame-photometry and atomic absorption spectroscopy - Chemical analysis of soil for total and available nutrients - Analysis of plants for essential elements.

References

1. Brady, N.C and Weil, R.R. (2002). *The Nature and properties of soils*. 13th Ed. Pearson Edu.
2. Kabata- Pendias, A and Pendias, H. (1992). *Trace elements in soils and plants*. CRC Press.
3. Mengel, K and Kirkby, E.A. (1982). *Principles of plant nutrition*. International Potash Institute, Switzerland
4. Mortvedt, J.J., Shuman, L.M., Cox, F.R and Welch, R.M. (1991). *Micronutrients in agriculture*. 2nd Ed. SSSA, Madison.
5. Prasad, R and Power, J.F. (1997). *Soil fertility management for sustainable agriculture*. CRC
6. Stevenson, F.J and Cole, M.A. (1999). *Cycles of soil: carbon, nitrogen, phosphorus, sulphur, micronutrients*. John Wiley & Sons.
7. Havlin, J.L., Beaton, J.D., Tisdale, S.L and Nelson, W.R. (2013). *Soil fertility and fertilizers*, 8th Ed. Pearson.
8. Troeh, F.R and Thompson, L.M. (2005). *Soils and soil fertility*. Blackwell.

21AG3217 EXPERIMENTAL DESIGNS

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Designing experiments for agricultural sciences.
2. Concepts involved in designing the experiments.
3. Planning and preparation of field layouts.

Course Outcomes:

On completion of this course, students will be able to

1. Summarize the concepts of design of experiments.
2. Explain principles of experimental designs.
3. Analyse and select optimum experimental design for their field research.
4. Apply the principles of designs while framing the field layouts.
5. Remember the applications of experimental designs.
6. Analyze the resolvable designs

Theory

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control. Uniformity trials, size and shape of plots and blocks; Analysis of variance; completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

Split plot and strip plot designs; analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

References

1. Cochran, W. G and Cox, G. M. (1957). *Experimental designs*. Second Edition, John Wiley.

2. Dean, A.M and Voss D. (1999). *Design and analysis of experiments*. Springer.
3. Federer, W. T. (1985). *Experimental designs*. MacMillan.
4. Fisher, R. A. (1953). *Design and analysis of experiments*. Oliver & Boyd.
5. Hoshmand, R. (2006). *Design of experiments for agriculture and the natural sciences*. Second Edition, Taylor & Francis.
6. Nigam, A. K and Gupta, V. K. (1979). *Handbook on analysis of agricultural experiments*. IASRI Publications.
7. Pearce, S. C. (1983). *The agricultural field experiment: A statistical examination of theory and practice*. John Wiley.
8. Design Resources Server: www.iasri.res.in/design

21AG3218 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. The basic concepts of remote sensing.
2. The application of remote sensing in general and with special reference to soil resource inventory, Crop stress and crop area mapping.
3. GIS and applications in agriculture.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basics of remote sensing.
2. Gain knowledge on sensors and image processing.
3. Interpret aerial photographs and imageries.
4. Learn the principles of GIS and its components.
5. Understand the spatial variabilities in soil and geo-statistical techniques.
6. Learn the applications of remote sensing and GIS techniques.

Theory:

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter. Sensor systems - Camera, Passive and Active Sensors; fundamentals of aerial photographs and image processing and interpretations. Introduction to GIS, components of GIS; data types-vector and raster. spatial and non-spatial data. GNSS (GPS) segments, working principles and GPS errors; Various GNSS systems. Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability. Application of remote sensing and GIS techniques - Soil surveys and soil resource inventory, crop stress assessment, crop area estimation and yield forecasting, watershed management, drought assessment and land degradation mapping.

Practical:

Familiarization with different remote sensing equipment and data products; Aerial photos and satellite data sources - Interpretation of Aerial photos and Satellite data - Digital image classification - Generation of base maps and attributes. Vector data analysis - Raster data analysis - change detection - GPS demonstration - Spatial variability mapping.

References

1. Thomas Lillesand, Ralph W. Kiefer and Jonathan Chipman. (2015). *Remote Sensing and Image Interpretation*, 7th Edition, Wiley India Publishers.
2. Chandra, A.M. and Ghosh, S.K. (2015). *Remote Sensing and Geographic Information System*. 2nd Edition. Narosa Publishing House New Delhi.

21AG3219 DATA ANALYSIS USING STATISTICAL PACKAGES

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Using various statistical packages.
2. Hands on experience in analyzing their own data.
3. Development of algorithms.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the procedure for analyzing through statistical packages.
2. Interpretation of results obtained from analysis.

3. Learn new and advanced softwares for biological data analysis.
4. Establish start-ups for data analysis.
5. Analyse time series data.
6. Interpretation the results of AMMI and Multivariate analyses.

Theory

Use of software packages for: Summarization and tabulation of data; Descriptive statistics; graphical representation of data, exploratory data analysis. Fitting and testing the goodness of fit of discrete and continuous probability distributions; Testing of hypothesis based on large sample test statistics; Testing of hypothesis using chi-square, t and F statistics. Concept of analysis of variance and covariance of data for single factor, multi-factor, one-way and multi-classified experiments, contrast analysis, multiple comparisons, analyzing crossed and nested classified designs. Analysis of mixed models; Estimation of variance components; testing the significance of contrasts; Correlation and regression including multiple regression. Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, fitting of non-linear models; Time series data; Spatial analysis; Neural networks.

Practical

Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data. Robust estimation, testing linearity and normality assumption, estimation of trimmed means etc., cross tabulation of data including its statistics, cell display and table format and means for different sub-classifications; Fitting and testing the goodness of fit of probability distributions; Testing the hypothesis for one sample t -test, two sample t -test, paired t -test, test for large samples - Chi-squares test, F test, One way analysis of variance, contrast and its testing, pair wise comparisons; Multi-way classified analysis of variance - Cross-classification, nested classification, factorial set up, fixed effect models, random effect models, mixed effect models, estimation of variance components; Generalized linear models - Analysis of unbalanced data sets, testing and significance of contrasts, estimation of variance components in unbalanced data sets - Maximum likelihood, ANOVA, REML, MINQUE; Bivariate and partial correlation, distances - to obtain a distance matrix, dissimilarity measures, similarity measures; Linear regression, multiple regression, regression plots, variable selection, regression statistics, fitting of growth models - curve estimation models, examination of residuals; Discriminant analysis - fitting of discriminant functions, identification of important variables, factor analysis. Principal component analysis - obtaining principal component, spectral composition; Analysis of time series data - fitting of ARIMA models, working out moving averages. Spatial analysis; neural networks.

References

1. Anderson, C.W and Loynes, R. M. (1987). *The Teaching of practical statistics*. John Wiley.
2. Atkinson, A.C. (1985). *Plots transformations and regression*. Oxford University Press.
3. Chambers, J.M., Cleveland, W.S., Kleiner, B and Tukey, P. A. (1983). *Graphical methods for data analysis*. Wadsworth, Belmont, California.
4. Chatfield, C and Collins, A. J. (1980). *Introduction to multivariate analysis*. Chapman and Hall.
5. Chatfield, C. (1983). *Statistics for technology*. 3rd Ed. Chapman & Hall.
6. Chatfield, C. (1995). *Problem solving: A statistician's guide*. Chapman & Hall.
7. Cleveland, W.S. (1985). *The elements of graphing data*. Wadsworth, Belmont, California.
8. Ehrenberg, A.S.C. (1982). *A primer in data reduction*. John Wiley.
9. Erickson, B.H and Nosanchuk, T.A. (1992). *Understanding data*. 2nd Ed. Open University Press, Milton Keynes.
10. Snell, E.J and Simpson, H. R. (1991). *Applied statistics: A handbook of genstat analyses*. Chapman & Hall Publications.
11. Sprent, P. (1993). *Applied non-parametric statistical methods*. 2nd Ed. Chapman & Hall Publications
12. Tufte, E.R. (1983). *The Visual display of quantitative information*. Graphics Press, Cheshire, Conn.
13. Velleman, P.F and Hoaglin, D.C. (1981). *Application, basics and computing of exploratory data analysis*. Duxbury Press.
14. Weisberg, S. (1985). *Applied linear regression*. John Wiley.
15. Wetherill, G.B. (1982). *Elementary statistical methods*. Chapman & Hall.

21AG3222 LIBRARY AND INFORMATION SERVICES

Credits: 1 (0+1)

Course Objectives:

To impart knowledge on

1. Skills to trace information from libraries efficiently.
2. Information and knowledge resources.
3. Literature survey.

Course Outcomes:

On completion of this course, students will be able to

1. Effectively utilize the library resources.
2. Formulate information search strategies.
3. Use modern tools for information search.
4. Document and store e-resources effectively.
5. Collect scientific data from Internet, OPAC and other search engines.
6. Track information from reference sources.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

21AG3223 TECHNICAL WRITING AND COMMUNICATIONS SKILLS

Credits: 1 (0+1)

Course Objectives:

To impart knowledge on

1. Writing dissertations and research papers.
2. Writing research projects without grammatical errors.
3. English verbal communications.

Course Outcomes:

On completion of this course, students will be able to:

1. Understand the basics of English.
2. Communicate and articulate in English.
3. Write thesis and research papers.
4. Make presentations on their dissertations.
5. Participate in Group Discussions of job interviews.
6. Review the research papers.

Practical

Technical Writing - Various forms of scientific writings - theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

References

1. Hornby, A.S. (2000). *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
2. Joseph, G. (2000). *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
3. Mohan, K. (2005). *Speaking English Effectively*. MacMillan India.
4. Robert, C. (Ed.). (2005). *Spoken English: Flourish Your Language*. Abhishek Publishers.
5. Sethi, J and Dhamija, P.V. (2004). *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
6. Wren PC & Martin H. (2006). *High School English Grammar and Composition*. S. Chand & Co.

21AG3224 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 (1+0)

Course Objectives:

To impart knowledge on

1. IPR and related protection systems.
2. Strategies to register inventions/designs, in India and abroad.
3. Use of IPR for wealth and value creation in a knowledge based country.

Course Outcomes:**On completion of this course, students will be able to**

1. Understand GATT, WTO, TRIPs and WIPO for IPR protection.
2. Know to acquire the patent and copyright for their innovative work.
3. Remember plagiarism, which can be questioned legally.
4. Explain UPOV, PPV, and FR Act of India.
5. Apply, Analyze and use ITK strategies.
6. Achieve new innovative goals.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

References

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill Publications
2. Intellectual Property Rights: Key to New Wealth Generation. (2001). NRDC & Aesthetic Technologies.
3. Ministry of Agriculture, Government of India. (2004). State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
4. Rothschild, M and Scott, N. (Ed.). (2003). Intellectual Property Rights in Animal Breeding and Genetics. CABI.
5. Saha, R. (Ed.). (2006). Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publication House.
6. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000
7. Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

21AG3225 BASIC CONCEPTS IN LABORATORY TECHNIQUES**Credits: 1 (0+1)****Course Objectives:****To impart knowledge on**

1. Basics of handling laboratory instruments.
2. Principles of common laboratory techniques.
3. Do's and Don'ts of laboratory techniques.

Course Outcomes:**On completion of this course, students will be able to**

1. Handle the laboratory equipments.
2. Prepare solutions of different concentrations and strengths.
3. Preparation and measuring the different pH solutions.
4. Basics of media preparation for micro propagation.
5. Test the viability of seeds and pollen grains.
6. Classify the flowering plants based on taxonomy.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vascupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

References

1. Furr, A.K. (2000). *CRC Hand Book of Laboratory Safety*. CRC Press.

- Gabb, M.H and Latchem, W.E. (1968). *A Handbook of Laboratory Solutions*. Chemical Publication Co.

21AG3226 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMS

Credits: 1 (1+0)

Course Objectives:

To impart knowledge on

- Functioning of Agricultural Research systems.
- National and International level organizations involved in Agricultural Research.
- Rural development Programs.

Course Outcomes:

On completion of this course, students will be able to

- Understand the research ethics.
- Remember the National and International agencies involved in Agricultural Research.
- Analyse the various Rural Development Programs.
- Apply their knowledge on understanding the policies of Government.
- Transfer their knowledge at International level.
- Attract International collaborations for doing Research.

Theory

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility. Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.

Rural development Programs: Community Development Program, Intensive Agricultural District Program, Special group – Area Specific Program, Integrated Rural Development Program (IRDP) Panchayati Raj Institutions, Co-operatives, and Voluntary Agencies/Non R Governmental Organisations. Critical evaluation of rural development policies and Programs. Constraints in implementation of rural policies and Programs.

References

- Bhalla, G.S and Singh, G. (2001). *Indian Agriculture - Four Decades of Development*. Sage Publication
- Punia, M.S. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
- Rao, B.S.V. (2007). *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publication.
- Singh, K. (1998). *Rural Development - Principles, Policies and Management*. Sage Publication.

21AG3227 INTRODUCTION TO BIOINFORMATICS

Credits: 3(2+1)

Course objectives:

To impart knowledge on

- Fundamental aspects of bioinformatics
- Basic principles of database searching
- Applications of bioinformatics in various disciplines

Course outcomes:

On Completion of this course, students will be able to

- Understand the basic concepts of bioinformatics
- Identify the information resources for data analysis
- Do searches for primary and secondary databases
- Create their own database search protocols
- Analyze bioinformatics softwares
- Explore web-based analysis tools

Theory

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, gene bank, DDBJ. Specialized genomic resources. DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR. Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

Usage of NCBI resources, Retrieval of sequence/structure from databases, Visualization of structures, Docking of ligand receptors, BLAST exercises.

References

1. Attwood, T.K and Parry-Smith, D.J. (2003). *Introduction to Bioinformatics*. Pearson Education.
2. Rastogi, S.C., Mendiratta, N and Rastogi, P. (2004). *Bioinformatics: Concepts, Skills and Applications*. CBS.

21AG3228 PHYSIOLOGICAL AND MOLECULAR RESPONSES OF PLANTS TO ABIOTIC STRESSES

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Different categories of abiotic stresses
2. Molecular basis of abiotic stresses
3. Species of abiotic stress tolerant plants

Course outcomes:

On Completion of this course, students will be able to

1. Understand mechanisms of abiotic stresses
2. Appraise the physiological pathways in response to abiotic stresses
3. Remember the Reactive Oxygen Species and scavenging systems
4. Understand the effect of abiotic stress on physiological processes
5. Remember the breeding approaches for stress resistance
6. Understand the role of proteins and enzymes involved in abiotic stress resistant pathways

Theory

Response of plants to abiotic stresses: Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, Interactions between biotic and abiotic stresses. Drought-characteristic features, Water potential in the soil-Plant air continuum. Development of water deficits, energy balance concept. Transpiration and its regulation – stomatal functions. Physiological processes affected by drought. Drought resistance mechanisms: Escape Dehydration postponement (Drought avoidance), Dehydration tolerance and characteristics of resurrection plants. Osmotic adjustment, Osmo-protectants, Stress proteins. Water use efficiency as a drought resistant trait. Molecular responses to water deficit: Stress perception, Expression of regulatory and functional genes and significance of gene products. Stress and hormones- ABA as a signaling molecule-Cytokinin as a negative signal. Oxidative stress: Reactive Oxygen Species (ROS). Role of scavenging systems (SOD catalase etc.). High temperature stress: Tolerance mechanisms- role of membrane lipids in high temperature tolerance. Functions of HSP's. Chilling stress: Effects on physiological processes. Crucial role of membrane lipids. Salinity: Species variation in salt tolerance. Salinity effects at – Cellular and whole plant level, tolerance mechanisms. Salt tolerance in – Glycophytes and halophytes, Breeding for salt resistance. Heavy metal stress: Aluminium and cadmium toxicity in acid soils. Role of Phytochelatins (heavy metal binding proteins).

Practical

Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression, Determination of soil water potential and content by psychrometry and other systems. Stress imposition and quantification, Stress –stomatal conductance. Canopy temperature as a reflection of transpiration and root activity, Water use – efficiency, Determination at whole plant and single leaf level, Root- shoot signals-ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. Sullivans heat tolerance test, chilling tolerance Galactolipase and free fatty acid levels as biochemical markers for chilling damage, Cold induced inactivation of O₂ evolution of chloroplasts- as a screening technique for chilling tolerance.

References

1. Hopkins, W.G and Huner, N.P.A. (2004). *Introduction to Plant Physiology*. John Wiley & Sons Publishing House.
2. Salisbury, F.B and Ross, C. (1992). *Plant Physiology*. 4th Ed. Wadsworth Publications.
3. Taiz, L and Zeiger, E. (2006). *Plant Physiology*. 4th Ed. Sinauer Associates.

21AG3232 CURRENT TOPICS IN NEMATODE DISEASE DEVELOPMENT AND HOST RESISTANCE

Credits: 3(2+1)

Course Objectives:

To impart knowledge on

1. Mechanisms in Plant- nematode interaction
2. Defense responses against nematode infection
3. Biotechnology and disease management approaches

Course Outcomes:

On completion of this course, students will be able to

1. Explain the mechanisms of pathogenesis and changes induced by nematodes in plants
2. Discuss about the induction of defense responses in plant system
3. Understand the genetic basis of plant resistance to nematodes
4. Explain about the biotechnological approaches in development of disease resistance plants
5. Interpret the conventional breeding techniques in nematode management
6. Discuss about the influence of microorganisms on plant nematode interactions.

Theory

Mechanisms of pathogenesis, cytological and biochemical changes induced by nematode feeding. Plant defense systems, role of phytoalexins etc. against major plant parasitic nematodes. Genetic basis of plant resistance to nematodes and identification of resistance genes against economically important nematodes. Application of biotechnological methods in the development of nematode resistant crop cultivars; resistance markers; incorporation of resistance by conventional breeding and transgenic approaches. Influence of microorganisms on plant nematode interactions.

Practical

Microtomy for study of histopathological changes induced by important nematodes, screening techniques for assessment of resistance in crop germplasm against nematodes.

References

1. Barker, K.R., Pederson, G.A and Windham, G.L. (1998). *Plant and Nematode Interactions*. CABI, Wallingford.
2. Fenoll, C., Grundler, F.M.W and Ohl, S.A. (1997). *Cellular and Molecular aspects of Plant-Nematode Relationships*. Kluwer Academic Press, Dordrecht.
3. Lamberti, F., Giorgi, C and Bird, D. (1994). *Advances in Molecular Plant Nematology*. Plenum Press.

21AG3233 ADVANCED DESIGN OF EXPERIMENTS

Credits: 2(2+0)

Course Objectives:

To impart knowledge on

1. Advanced statistical designs
2. Hands on experience in analyzing their own data
3. Developing their own algorithms

Course Outcomes:

On completion of this course, students will be able to

1. Understand the procedure for analyzing through statistical packages
2. Interpret the results obtained from analysis
3. Develop new softwares for biological data analysis
4. Establish start-ups for data analysis
5. Analyze time series data
6. Interpret the results of canonical and ridge analysis

Theory

General properties and analysis of block designs. Balancing criteria. Massocciate PBIB designs, and their association schemes including lattice designs - properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs, Mating designs. General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs. Structurally Incomplete block designs, Designs for two sets of treatments. Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Regular and irregular fractions. Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking. Canonical analysis and ridge analysis. Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors. Optimality criteria and optimality of designs, robustness of designs against loss of data, outliers, etc. Diagnostics in design of experiments.

References

1. Chakraborti, M.C. (1962). *Mathematics of Design and Analysis of Experiments*. Asia Publishing House.
2. Dean, A.M and Voss, D. (1999). *Design and Analysis of Experiments*. Springer.
3. Dey, A and Mukerjee, R. (1999). *Fractional Factorial Plans*. John Wiley.
4. Dey, A. (1986). *Theory of Block Designs*. Wiley Eastern.
5. Hall, M.(Jr). (1986). *Combinatorial Theory*. John Wiley.
6. Hedayat, A.S., Sloane, N.J.A and Stufken J. (1999). *Orthogonal Arrays: Theory and Applications*. Springer.
7. John, J.A and Quenouille, M.H. (1977). *Experiments: Design and Analysis*. Charles & Griffin.
8. Montgomery, D.C. (2005). *Design and Analysis of Experiments*. John Wiley.
9. Ogawa, J. (1974). *Statistical Theory of the Analysis of Experimental Designs*. Marcel Dekker.
10. Design Resources Server: www.iasri.res.in

21AG3235 MATHEMATICAL MODELING IN AGRICULTURAL SCIENCES

Credits: 2(1+1)

Course Objectives:

To impart knowledge on

1. The basic principles of mathematical modeling
2. Mathematical modeling methods and techniques.
3. Applications of mathematical modeling in agricultural research.

Course Outcomes:

On completion of this course, students will be able to

1. Understand about various matrices
2. Learn the basics of calculus
3. Understand different kinds of mathematical model, their classification and properties
4. Execute growth models and spacing models
5. Implement response models
6. Gain thorough insights on simulation exercise

Theory

Matrices - Review of matrix Algebra, Matrix types, Algebra of matrices, inverse of a matrix by adjoint method, solving simultaneous equations using matrix inverse and Cramer's rule, Leslie matrix – simple applications in Population Dynamics. Calculus – Differentiation, definition, methods of differentiation, Partial differentiation, Increasing and decreasing function, Maxima and minima of single and several variables without constraints. Integration – methods of integration (method of substitution, method of partial fractions) and Integration by parts (simple problems). Formation – First order: Variable separable – Homogenous – Linear Differential Equations - Second order differential equation, Growth rate – Relative growth rate - Application of calculating integration in area, volume and surface area - Estimating growth function from growth rate and relative growth rates. Mathematical models – Systems, Definitions, Components of a system, Modeling approach, Different kinds of models, Mathematical model, their classification and properties, Simulation, Definition, Examples. Growth Models, uses in Agriculture, Linear, Stage wise, Exponential, Logistic, Richards, Gempertz and Mitcherlich Yield response models in single and multiple inputs – Quadratic – Square root – Mitcherlich's response models - single input – Quadratic and square response models for several inputs, Estimating physical and Economic optimum.

Practical

Problems in Algebra of matrices, inverse of a matrix by adjoint method, solving simultaneous equations using matrix inverse and Cramer's rule. Leslie matrix, simple applications in Population Dynamics. Problems in Differentiation, methods of differentiation, Partial differentiation, increasing and decreasing function, Maxima and minima of single and several variables without constraints. Problems in Integration method of substitution, method of partial fractions and Integration by parts (simple problems). Problems in First order differential equations, Variable separable, Homogenous, Linear Differential Equations, Second order differential equation with constant coefficient. Problems in Growth rate, Relative growth rate, Application of calculating integration in area, volume and surface area, Estimating growth function from growth rate and relative growth rates. Problems in Mathematical model, their classification and properties, Simulation, Examples, Growth Models, Linear, Stage wise, Exponential, Logistic, Richards, Gempertz and Mitcherlich. Problems in Yield response models in single and multiple inputs, Quadratic, Square root, Mitcherlich's response models, single input, Quadratic and square response models for several inputs - Estimating physical and Economic optimum.

References

1. Ranganathan, C.R. (2006). *A First Course in Mathematical Models of population Growth (with MATLAB Programs)*. Associated Publishing Company, New Delhi.

2. Batschelet Edward. (2004). *Introduction to Mathematics for Life sciences*. 5th edition, Springer Verlag Publishers.
3. Manickavasagam Pillai, T. K and Natarajan, T. (1989). *Calculus*. Viswanathan Publications.
4. Mehta, B. C and Madhani, G. M. K. (2005). *Mathematics for Economists*. Sultan Chand and Sons, New Delhi.

21AG3236 WEATHER FORECASTING METHODS AND YIELD PREDICTION

Credits: 3 (2+1)

Course Objectives:

To impart knowledge on

1. Weather forecasting and yield prediction using models.
2. Different crop simulation models.
3. Minimizing crop risk due to natural calamities

Course Outcomes:

On completion of this course, students will be able to

1. Understand the weather forecasting systems in relation to crop production.
2. Expertise in various methods of weather forecasts.
3. Understand the principles in crop simulation modeling.
4. Get exposed to different crop simulation models.
5. Learn the details of crop yield prediction.
6. Plan measures to overcome natural calamities for minimizing its risk in crop production.

Theory

Weather forecasting system: definition, current status of climate predictions, scope and importance; Agencies involved, Approaches, Types and methods of weather forecast, types of forecasting: now, short, medium, extended range, long-range and special; Probabilistic, deterministic weather forecast; study of synoptic charts, synoptic features and weather anomalies and interpretation of satellite pictures of clouds in visible and infra-red range; weather forecasting network. Methods of weather forecasts - synoptic, numerical prediction, statistical, analogue, persistence and climatological approach, Indigenous Technical Knowledge (ITK) – Astrometeorology, signals from behavior of biological organisms and other events; various methods of verification of location-specific weather forecast. Models: Introduction, scope and importance; crop simulation models – list, development history, principles, special features, calibration and validation, DSSAT, EPIC, APSIM, WOFOST, Aquacrop, infocrop, ORYZA, DNDC, cropsyst, GLAM and DOME. Comparison of all the crop simulation models. Use of SWAT for crop simulation. Crop yield prediction: Definition, importance, yield prediction system – agrometeorology, land based observations, satellite; Crop growth monitoring system; yield prediction methods statistical, crop simulation models; Coupling crop models with seasonal climate forecast; historical analog, stochastic disaggregation; Improvements for accurate crop yield prediction. Impact assessment under different scenarios of temperature, rainfall, Carbon dioxide levels and their combined effect on crop yield; Impact of various management options on yield at field scale, regional scale and national. Special forecasts: special forecasts for natural calamities such as drought, floods, high winds, cold (frost) and heat waves, hail storms, cyclones and protection measures against such hazards.

Practical

Weather forecasting techniques - Synoptic charts – statistical - numerical- ENSO based seasonal climate forecast. Verification of weather forecast through different techniques. Extended range of weather forecast, disaggregation techniques. Introduction to minimum data sets for crop weather models, collection of weather, crop management information and crop yield data. Crop yield prediction techniques –Statistical, crop simulation model, remote sensing, Coupling crop simulation and remote sensing and Crop yield prediction through crop simulation models. Model acquisition (DSSAT, APSIM, Aquacrop and Infocrop), exposure to discussion forums, installation, simulation, calibration and validation, multiple simulations: Seasonal, sequential and spatial simulation. Sensitivity analysis for climate variability, other inputs and management practices. Utilizing extended range of forecast in crop simulation models.

References

1. Frere, M and Popav, G. (1979). *Agrometeorological Crop Monitoring and Forecasting*. F.A.O. Rome.
2. Hanks, R. J. (1974). *Model for predicting plant yield as influenced by water use*. Agronomy Journal, 65, 660–665.
3. Keulen, H. Van and Seligman, N. G. (1986). *Simulation of Water Use, Nitrogen Nutrition and Growth of a Spring Wheat Crop*. Simulation monographs. PUDOC, Wageningen.
4. Storm Dunlop. (2008). *Guide to Weather Forecasting*. George Philip & Sons, London.
5. Terri Siever. (2005). *Weather Forecasting*. Capstone Publisher, USA.

6. Mannava, V. K. Sivakumar and James Hansen. (2007). *Climate Prediction and Agriculture: Advances and Challenges*. Springer, New York. FAO.

**DEPARTMENT OF
AGRICULTURE**

LIST OF NEW COURSES (2020)

S. No.	Course Code	Name of the Course	Credits
1	20AG1001	Introductory Biology	2 (1+1)
2	20AG1002	Introductory Agro-meteorology & Climate Change	2(1+1)
3	20AG1003	Fundamentals of Genetics	3(2+1)
4	20AG1004	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
5	20AG1005	Introduction to Forestry	2 (1+1)
6	20AG1006	Fundamentals of Soil Science	3(2+1)
7	20AG1007	Fundamentals of Entomology	4(3+1)
8	20AG1008	Agricultural Microbiology	2(1+1)
9	20AG1009	Principles of Soil Science	3(2+1)
10	20AG1010	Human Values & Ethics (non gradial)	1(1+0)**
11	20AG1011	NCC/NSS	1(0+1)
12	20AG1012	Physical Education	1(0+1)
13	20AG2001	Rural Agricultural Work Experience (RAWE) and Agro Industrial Attachment (AIA)	20(0+20)
14	20AG2002	Experiential Learning Programme (ELP) (Module I and II)	20 (0+20)
15	20AG2003	Entrepreneurship Development and Business Communication	2 (1+1)
16	20AG2004	Communication Skills and Personality Development	2(1+1)
17	20AG2005	Practical Crop Production – I (<i>Kharif</i> crops)	2 (0+2)
18	20AG2006	Practical Crop Production –II (<i>Rabi</i> crops)	2 (0+2)
19	20AG2007	Geoinformatics and Nano-technology and Precision Farming	2 (1+1)
20	20AG2008	Fundamentals of Plant Breeding	3 (2+1)
21	20AG2009	Production Technology for Vegetables and Spices	2 (1+1)
22	20AG2010	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
23	20AG2011	Educational tour I	1(0+1)
24	20AG2012	Educational tour II	1(0+1)
25	20AG2013	Principles of Seed Technology	3(1+2)
26	20AG2014	Manures, Fertilizers and Soil Fertility Management	3 (2+1)
27	20AG2015	Fundamentals of Plant Pathology	4(3+1)
28	20AG2016	Diseases of Field and Horticultural Crops and their Management-II	3 (2+1)
29	20AG2017	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
30	20AG2018	Environmental Sciences and Disaster Management	3(2+1)
31	20HO1001	Plant Propagation and Nursery Management	2(1+1)
32	20HO1002	Weed Management in Horticultural Crops	2(1+1)
33	20HO1003	Fundamentals of Food Technology	2(1+1)
34	20HO1004	Principles of Landscape Architecture	2(1+1)
35	20HO1005	Fundamentals of Soil Science	2(1+1)
36	20HO1006	Water Management in Horticultural Crops	2(1+1)
37	20HO1007	Agro-meteorology and Climate Change	2 (1+1)
38	20HO1008	Economics and Marketing	3(2+1)
39	20HO1009	Elementary Plant Biochemistry	2(1+1)
40	20HO1010	Elementary Plant Biotechnology	2(1+1)
41	20HO1011	Introductory Crop Physiology	2(1+1)
42	20HO1012	Introductory Microbiology	2(1+1)

43	20HO1013	Fundamentals of Extension Education	2 (1+1)
44	20HO2001	Tropical and Subtropical Fruits	3(2+1)
45	20HO2002	Orchard and Estate Management	2(1+1)
46	20HO2003	Plantation Crops	3(2+1)
47	20HO2004	Temperate Fruit Crops	2(1+1)
48	20HO2005	Breeding of Fruits and Plantation Crops	3(2+1)
49	20HO2006	Tropical and Subtropical Vegetables	3(2+1)
50	20HO2007	Spices and Condiments	3(2+1)
51	20HO2008	Breeding of Vegetable, Tuber and Spice Crops	3 (2+1)
52	20HO2009	Temperate Vegetable Crops	2(1+1)
53	20HO2010	Potato and tuber crops	2 (1+1)
54	20HO2011	Postharvest Management of Horticultural Crops	3(2+1)
55	20HO2012	Processing of Horticultural Crops	3(1+2)
56	20HO2013	Ornamental Horticulture	2(1+1)
57	20HO2014	Medicinal and Aromatic crops	3 (2+1)
58	20HO2015	Soil Fertility and Nutrient Management	2(1+1)
59	20HO2016	Soil, Water and Plant Analysis	2(1+1)
60	20HO2017	Organic Farming	3 (2+1)
61	20HO2018	Horti-Business Management	2(2+0)
62	20HO2019	Rural Horticultural Work Experience (RHWE)	20 (0+20)
63	20AT2001	Sprinkler and Micro irrigation systems	2(1+1)
64	20AT2002	Engineering Properties of Agricultural Produce	2(1+1)
65	20AT2003	Remote Sensing and GIS Applications (Elective)	3(2+1)
66	20AT2004	Human Engineering and Safety (Elective)	3(2+1)
67	20AT2005	Waste and By-products Utilization (Elective)	3(2+1)
68	20AT2006	Introductory soil and water conservation Engineering	2(1+1)
69	20AT2007	Credit Seminar	1(0+1)

20AG1001 - INTRODUCTORY BIOLOGY

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The living world- diversity, origin , evolution and eugenics
2. The Binomial nomenclature, cell biology, morphology and plant systematic of flowering plants (Brassicaceae, Fabaceae and Poaceae)
3. The role of animals in agriculture

Course Outcomes:

On completion of this course, students will be able to

1. Explain the diversity, evolution and eugenics of living world
2. Classify organisms based on Binomial nomenclature
3. Illustrate the morphological classification of flowering plants
4. Analyse the seed germination process - cell division to organ development
5. Apply plant systematics in agricultural studies
6. Relate the role of draught animals and animal husbandry in agriculture

Theory

Introduction to the living world diversity and characteristics of life, origin of life - Evolution and Eugenics. Binomial nomenclature and classification- Cell and cell division - Morphology of flowering plants - Seed and seed germination - Plant systematic- viz. - Brassicaceae, Fabaceae and Poaceae, Role of animals in agriculture.

Practical

Morphology of flowering plants – root, stem and leaf and their modifications. Inflorescence, flower and fruits. Cell, tissues & cell division, Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - Brassicaceae, Fabaceae and Poaceae.

Text Books

1. Daniel Sundararaj, D. and G. Thulasidas, 1993. Botany of field crops. MacMillan India Ltd., New Delhi.
2. Sambamurthy, V.S. and N.S. Subramanian, 1989. Text Book of Economic Botany, Wiley Eastern, New Delhi
3. Albert F. Hill and O.P. Sharma, 1996. Economic Botany. Tata McGraw - Hill Publishing Co. Ltd., New Delhi.
4. Purse glow, 1988. Tropical Crops - Monocotyledons. The English Language book, Society and Longman Co, Singapore

20AG1002 - INTRODUCTORY AGRO-METEOROLOGY & CLIMATE CHANGE

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Agricultural meteorology and its role in crop production
2. Atmospheric weather variables, climatic factors and their measurements
3. Climate change and its effect on crop production

Course Outcomes:

On completion of this course, students will be able to

1. Understand the significance of agricultural meteorology, climate and weather
2. Discuss the various atmospheric weather variables and its significance in crop production
3. Understand crop weather relationships for efficient crop production
4. Acquire knowledge on weather forecasting techniques and effect of climate change on crop production
5. Describe artificial rainmaking, precipitation, monsoons and its importance in Indian agriculture
6. Discuss global warming, and its effect on regional and national agriculture

Theory

Meaning and scope of agricultural meteorology; earth atmosphere- its composition, extent and structure; atmospheric weather variables; atmospheric pressure, its variation with height; wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze. Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature. Energy balance of earth; atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; artificial rainmaking. Monsoon-mechanism and importance in Indian agriculture, weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat wave and cold wave. Agriculture and weather relations; modifications of crop microclimate, climatic normal for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national agriculture.

Practical

Visit of agrometeorological observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of radiation intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind

speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

Text Books

1. Prasada Rao, G.S.L.H.V. 2005. Agricultural Meteorology. Second Edition. Kerala Agricultural University, Thrissur
2. Mavi, H.S. 1986. Introduction of Agrometeorology. Oxford & IBH Publishing Co. New Delhi
3. Varshneya, M.C. and B.Balakrishna Pillai. 2003. Textbook of Agricultural Meteorology. ICAR, New Delhi

20AG1003 - FUNDAMENTALS OF GENETICS

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Fundamentals of Mendelian inheritance and gene interactions
2. Concept of linkage and its determination, chromosomal aberrations and ways to induce it.
3. Cytoplasmic inheritance and its applications, genetic makeup of cell and the process and regulation of gene synthesis

Course Outcomes:

On completion of this course, students will be able to

1. Solve problems on Mendelian genetics
2. Construct gene map using linkage
3. Identify the type of aberrations and its usage in agriculture
4. Understand inducing mutation by artificial methods
5. Explain the central dogma of life
6. Adopt the knowledge of cytoplasmic inheritance in plant breeding

Theory

Pre- and post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; special types of chromosomes. Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and chi-square. Dominance relationships, epistatic interactions with example. Multiple alleles, pleiotropism and pseudoalleles, sex determination and sex linkage, sex limited and sex influenced traits, blood group genetics, linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications, use of haploids, dihaploids and doubled haploids in genetics. Mutation, classification, methods of inducing mutations and CIB technique, mutagenic agents and induction of mutation. Qualitative and quantitative traits, polygenes and continuous variations, multiple factor hypothesis, cytoplasmic inheritance. Genetic disorders. Nature, structure and replication of genetic material. Protein synthesis, transcription and translational mechanism of genetic material, gene concept: gene structure, function and regulation, lac and trp operons.

Practical

Study of microscope. Study of cell structure. Mitosis and meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, experiments on epistatic interactions including test cross and back cross, practice on mitotic and meiotic cell division, experiments on probability and chi-square test. Determination of linkage and crossover analysis (through two-point test cross and three point test cross data). Study on sex linked inheritance in *Drosophila*. Study of models on DNA and RNA structures.

References

1. Gardner, J.,M. J.Simmons and D.P.Snustad, 2009. Principles of Genetics (8th Ed.). Wiley India Pvt. Ltd., New Delhi.
2. Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
3. Singh, B.D. 2000. Fundamentals of Genetics (6th Ed.).Kalyani Publishers, Ludhiana
4. Singh, P. 1995. Elements of Genetics. Kalyani Publishers, Ludhiana.
5. <http://www.agrimoon.com/agriculture-icar-ecourse-pdf-book/> TNAU (ICAR)

20AG1004 - FUNDAMENTALS OF PLANT BIOCHEMISTRY AND BIOTECHNOLOGY

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Role of biochemistry in medicine, agriculture and pharmaceutical industries
2. Importance of biomolecules with structure, classification and function
3. Synthesis and storage of metabolic energy

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of biomolecules in medicine, agriculture, pharmaceuticals and ethics
2. Recall the role of biomolecules in photosynthesis, protein synthesis and DNA synthesis
3. Analyse the structure and classification of biomolecules
4. Remember the developments in biochemistry
5. Explain the overall aspects of integration of metabolic processes
6. Apply the knowledge on structure of carbohydrates, proteins, vitamins, nucleic acids and lipids in drug discovery

Theory

Importance of biochemistry. Properties of water, pH and buffer. Carbohydrate: importance and classification. Structures of monosaccharides, reducing and oxidizing properties of monosaccharides, mutarotation; structure of disaccharides and polysaccharides. Lipid: importance and classification; structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: importance of proteins and classification; structures, titration and zwitterions nature of amino acids; structural organization of proteins. Enzymes: general properties; classification; mechanism of action; Michaelis-Menten and Lineweaver-Burk equation and plots; introduction to allosteric enzymes. Nucleic acids: importance and classification; structure of nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: beta-oxidation, biosynthesis of fatty acids. Concepts and applications of plant biotechnology: scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications. Micro-propagation methods; organogenesis and embryogenesis, synthetic seeds and their significance; embryo rescue and its significance; somatic hybridization and cybrids; somaclonal variation and its use in crop improvement. Cryo-preservation; introduction to recombinant DNA methods: physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods; Transgenics and its importance in crop improvement; PCR techniques and its applications; RFLP, RAPD, SSR; Marker Assisted Breeding in crop improvement; Biotechnology regulations.

Practical

Preparation of solution, pH and buffers, qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids, effect of pH, temperature and substrate concentration on enzyme action, paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides. Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants. Micro-propagation, hardening and acclimatization. Demonstration on isolation of DNA. Demonstration of gel electrophoresis techniques and DNA finger printing.

References

1. Jain, L. 2001. Fundamentals of Biochemistry, 5th Edition, S. Chand & company, New Delhi.
2. Lehninger, A.L., D.L. Nelson and M.M. Cox. 2017. Principles of Biochemistry. W.H. Freeman and Company (MacMillan Publishers), USA
3. Thayumanavan, B, S. Krishnaveni and K. Parvathi. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications, New Delhi.
4. Verma, S.K. 2000. A Text Book of Plant Physiology and Biochemistry, S. Chand & company, New Delhi.
5. Brown T A. 2002. Genomes 2. 2nd ed. New York: Wiley-Liss.
6. Prave P, Faust U & Sittig W. 1987. Fundamentals of Biotechnology. VCH

Verlagsgesellschaft.

7. Chawla, H.S. 2012. Introduction to plant biotechnology. IBH publishing Co.
8. Singh, B. D. 2013. Molecular biology, genetic engineering and applications of biotechnology. Kalyani Publishers

20AG1005 - INTRODUCTION TO FORESTRY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The importance of forest and agroforestry systems in sustaining the land productivity
2. Crop tree interactions in different types of agroforestry systems
3. Productive and protective functions of agroforestry

Course Outcomes:

On completion of this course, students will be able to

1. Understand the forest eco system and forest regeneration.
2. Remember the concepts of agroforestry practiced in various agro ecosystems
3. Apply the knowledge for developing agro forestry, wind breaks, shelter belts, silviculture and social forestry
4. Recall the multipurpose trees in agroforestry systems
5. Analyse the impact of nitrogen fixation, carbon sequestration and develop strategies for climate mitigation
6. Explain the beneficial effects of agro forestry in relation to nitrogen fixation, soil conservation, litter dynamics and nutrient cycles

Theory

Introduction – definitions of basic terms related to forestry, importance and objectives of silviculture, types of forests-salient features of Indian forest policies. Forest regeneration, natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations- tree stand management. Agroforestry – definition and concepts agroforestry systems and practices- different agroforestry systems prevalent in the country and Tamil Nadu, shifting cultivation, taungya, alley cropping, windbreaks and shelterbelts, plantation crop combinations, home gardens. Multipurpose trees in agroforestry, characteristics- under storey components and diversification potentials - component interactions- above ground and below ground interactions. Productive and protective functions - nitrogen fixation- soil conservation- litter dynamics and nutrient cycling – carbon sequestration and climate change mitigation - social forestry- concept and importance, practices in different agro ecosystems

Practical

Identification of tree-species. Diameter measurements using calipers and tape. Height measurement of standing trees by shadow method, single pole method and hypsometer. Nursery lay out, seed sowing, vegetative propagation techniques. Different agroforestry systems like agrisilvicultural systems, silvopastoral systems, agrosilvopastoral systems and their interactions

References

1. Puri, S and Panwar, P. (ed.). 2007. Agroforestry Systems and Practices. New India Publishing Agency, New Delhi.
2. Gupta, R.K. 1993. Multipurpose Trees for Agroforestry and Wasteland Utilization. Oxford and IBH.
3. Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publications, Dordrecht, The Netherlands.

20AG1006 - FUNDAMENTALS OF SOIL SCIENCE

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Soil forming process and physical properties of soil

2. Soil chemical properties and reactions
3. Impact of soil pollution and remediation measures

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genesis, pedological and edaphological concepts of soil
2. Remember different systems of soil classification
3. Explain and evaluate the physical properties of soil
4. Explain and estimate the physio- chemical properties of soil
5. Describe the biological properties of soil and its influence
6. Analyse the soil pollutant factors and recommend suitable remedial measures for soil improvement

Theory

Soil as a natural body, pedological and edaphological concepts of soil; soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; soil profile, components of soil; soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; elementary knowledge of soil taxonomy classification and soils of India; soil water retention, movement and availability; soil air, composition, gaseous exchange, influence on plant growth, soil temperature; source, amount and flow of heat in soil; effect on plant growth, soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids- inorganic and organic; silicate clays: constitution and properties; sources of charges; ion exchange, cation exchange capacity, base saturation; soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and microorganisms, their beneficial and harmful effects; soil pollution - point and non-point sources behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Study of soil profile in field. Identification of glasswares and laboratory rules. Preparation of standard solution and standardization (concept of normality, molarity, molality, ppm) Study of soil sampling tools, collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil. Determination of soil colour. Determination of soil heat. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Estimation of organic matter content of soil.

References

1. Black, C.A. 1982. Methods of Soil Analysis, Part I ASA, Madison, USA.
2. Brady, N.C. 2016. Nature and Properties of Soils. 15th Edn., Macmillan Publishing Co. Inc., New York.
3. Das, D.K. 2015. Introductory Soil Science. 4th Edn., Kalyani Publishers, New Delhi.
4. Indian Society of Soil Science. 2012. Fundamentals of Soil Science (2nd Edn.). IARI, New Delhi
5. Biswas, T.D. and S.K.Mukherjee, 2016. Text Book of Soil Science. (2nd Edn). Tata McGraw Hill Publishing Co., New Delhi.
6. <https://agrimoon.com/introduction-to-soil-science-icar-ecourse-pdf-book/>
7. <https://www.pdfdrive.com/principles-and-practice-of-soil-science-the-soil-as-a-natural-resource/>

20AG1007 - FUNDAMENTALS OF ENTOMOLOGY

Credits: 3:0:1 (3+1)

Course objectives:

To impart knowledge on

1. Insect morphology, anatomy and physiology
2. Insect systematics
3. Insect ecology, classification of pesticides and concept of different pest management techniques

Course outcomes:

On completion of this course, students will be able to

1. Understand insect external body parts and their modifications
2. Remember insect orders and families of agriculturally important pests
3. Acquire knowledge on structure of various organ systems and their functions
4. Analyse the factors influencing pest occurrence
5. Explain the basis of insect ecology
6. Recommend integrated pest management strategies

Theory

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouthparts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance.

Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control importance, hazards and limitations. Recent methods of pest control, repellents, anti-feedants, hormones, attractants, and gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes.

Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of biotype, sub-species, species, genus, family and order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae. Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; external features of grasshopper/blister beetle; types of insect antennae, mouthparts and legs; wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; dissection of digestive system in insects (grasshopper); dissection of male and female reproductive systems in insects (grasshopper); study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides, their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

References

1. Gullan, P. J. and Cranston, P. S. 2014. The insects: an outline of entomology. (8th Ed.) Wiley Blackwell
2. Metcalf, C. L. and Flint, W. P. 1973. Destructive and Useful Insects. Tata Mc Graw Hill Publishing Co. New Delhi.
3. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. 1979. General and Applied Entomology. Tata Mc Graw Hill Publishing Co. New Delhi.
4. Naumann, I. D. 1991. The Insects of Australia a text book of students and research workers

- Vol. I & II (2nd Ed.) Commonwealth Scientific and Industrial Research Organisation. Melbourne University Press.
5. Pant, N. C. and Ghai, S. 1973. Insects Physiology and Anatomy. I CAR. New Delhi, 332 p. 6.
 6. Richards, O. W. and Davies, R. G. 1977. Imms General Textbook of Entomology. Vol. II Chapman and Hall, London.
 7. Snodgrass, R. E. 1935. Principles of Insect Morphology. Tata Mc Graw Hill Publishing Co. New Delhi.

20AG1008 - AGRICULTURAL MICROBIOLOGY

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of microorganisms in agriculture and understanding of soil microbiology
2. Classification of microorganisms, functions and its role in soil fertility
3. Scope of microbes in human welfare, production of silage, biofertilizers, biopesticides, biofuels, and biodegradation of agricultural wastes

Course Outcomes:

On completion of this course, students will be able to

1. Comprehend the importance and role of microbes in agricultural production
2. Understand principles of microscopy, sterilization techniques and nutrient media preparation
3. Enumerate microbial load in soil and perform isolation, culturing and purification of microbes
4. Explain the role of microbes in enhancing soil fertility
5. Employ genetic transformation methods using microbes in crop improvement
6. Explore and develop biofertilizers, biopesticides and biofuels

Theory

Introduction. Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro- waste.

Practical

1. Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture.
2. Methods of sterilization.
3. Nutritional media and their preparations.
4. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.
5. Methods of isolation and purification of microbial cultures.
6. Isolation of *Rhizobium* from legume root nodule.
7. Isolation of *Azotobacter* from soil.
8. Isolation of *Azospirillum* from roots. Isolation of BGA.
9. Staining and microscopic examination of microbes.

References

1. Alexander, M. 1985. Introduction to Soil Microbiology .John Wiley & Sons , New York.
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 1993. Microbiology. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Stanier, R.Y., Ingraham, Wheelis, M.G. and Paintor, P.R. 1986. The Microbiology World. Prentice Hall, New Jersey.
4. Subba Rao, N.S. 1999 .Biofertilizers in Agricultural and Agroforestry .Oxford & IBH New Delhi
5. <http://www.agrimoon.com/agriculture-icar-ecourse-pdf-book/> TNAU (ICAR)

20AG1009 - Principles of Soil Science

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The soil forming factors and processes.
2. Physical, chemical and biological properties and fertility status of the soil.
3. Reclamation of salt affected soils, saline irrigation water and their management

Course Outcomes:

On completion of this course, students will be able to

1. Understand the process of soil formation.
2. Determine the physical properties of the soil.
3. Evaluate the chemical and biological properties of soil.
4. Determine the fertility status of the soil by soil estimation and plant analysis
5. Recommend reclamation and management practices for salt affected soils and saline irrigation water
6. Assess the properties and utilities of liquid fertilizers.

Theory

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders; important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acidic, saline and sodic soils; quality of irrigation water; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. Use of saline and sodic water for crop production, gypsum requirement for reclamation of sodic soils and neutralizing RSC; liquid fertilizers and their solubility and compatibility.

Practical

Identification of rocks and minerals; examination of soil profile in the field; collection of soil sample; determination of bulk density; particle density and porosity of soil; determination of organic carbon of soil; determination of nitrogen, determination of phosphorus and determination of potassium; identification of nutrient deficiency symptoms of crops in the field; determination of gypsum requirement of sodic soils; determination of water quality parameters.

Suggested Readings

1. Brady, N.C. 2016. Nature and Properties of Soils. 15th Edn, Macmillan Publishing Co. Inc., New York.
2. Indian Society of Soil Science. 2012. Fundamentals of Soil Science. (2nd Edn). Indian Agricultural Research Institute, New Delhi.
3. Sehgal J. 2015. A Textbook of Pedology. Concepts and Applications. Kalyani Publishers. New Delhi.
4. Das, D.K. 2015. Introductory Soil Science. (4th Edn). Kalyani Publishers, New Delhi.
5. Biswas, T.D. and Mukherjee, S.K. 2016. Text Book of Soil Science. (2nd Edn). Tata McGraw Hill Publishing Co., New Delhi.
6. <https://agrimoon.com/introduction-to-soil-science-icar-ecourse-pdf-book/>
7. <https://www.pdfdrive.com/principles-and-practice-of-soil-science-the-soil-as-a-natural-resource/>

20AG1010 - HUMAN VALUES AND ETHICS

Credits: 1:0:0 (1+0)

Course objectives

To impart knowledge on

1. Value based living
2. How to become a good leader
3. Identifying humanitarian problems and offer solution

Course outcomes:

On completion of this course, students will be able to

1. Understand the importance of value based living.
2. Gain deeper understanding about the purpose of their life
3. Become value based professionals
4. Lead a balanced life with emotional stability
5. Set realistic goals in life and start working towards them.
6. Become leaders with social concern

Theory

Values and Ethics-An Introduction. Goal and Mission of Life. Vision of Life. Principles and Philosophy. Self-Exploration. Self-Awareness. Self-Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

20AG1011 - NCC/NSS

Credits: 0:0:1 (0+1)

National Cadet Corps I

1. Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
2. Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
3. Sizing, numbering, forming in three ranks, open and close order march and dressing.
4. Saluting at the halt, getting on parade, dismissing and falling out.
5. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear.
6. Turning on the march and wheeling. Saluting on the march.
7. Marking time, forward march and halt.
8. Changing step, formation of squad and squad drill.
9. Command and control, organization, badges of rank, honours and awards
10. Nation Building- cultural heritage, religions, traditions and customs of India. National integration.
11. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen.
12. Leadership traits, types of leadership. Character/personality development.
13. Civil defense organization, types of emergencies, fire fighting, protection,
14. Maintenance of essential services, disaster management, aid during development projects.
15. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
16. Structure and function of human body, diet and exercise, hygiene and sanitation.
17. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.
18. Adventure activities
19. Basic principles of ecology, environmental conservation, pollution and its control.
20. Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self defense.

National Cadet Corps II

1. Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.
2. Shoulder from the order and vice-versa, present from the order and vice-versa.
3. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa.
4. Guard mounting, guard of honour, Platoon/Coy Drill.
5. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting.

6. Loading, cocking and unloading. The lying position and holding.
7. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
8. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing.
9. Characteristics of Carbine and LMG.
10. Introduction to map, scales and conventional signs. Topographical forms and technical terms.
11. The grid system. Relief, contours and gradients. Cardinal points and finding north. Types of bearings and use of service protractor.
12. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map.
13. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
14. Field defenses obstacles, mines and mine lying. Bridging, waterman ship
15. Field water supplies, tracks and their construction.
16. Nuclear, Chemical and Biological Warfare (NCBW)
17. Judging distance. Description of ground and indication of landmarks.
18. Recognition and description of target. Observation and concealment. Field signals. Section formations.
19. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
20. Types of communication, media, latest trends and developments.

National Service Scheme I

Introduction and basic components of NSS:

Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

NSS programmes and activities

Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth

Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilisation

Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership

Social harmony and national integration

Indian history and culture, role of youth in nation building, conflict resolution and peace- building

Volunteerism and shramdan

Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

Citizenship, constitution and human rights

Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information

Family and society

Concept of family, community (PRIs and other community based organisations) and society

National Service Scheme II

Importance and role of youth leadership

Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

Life competencies

Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

Youth development programmes

Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organisations

20AG1012 - PHYSICAL EDUCATION

Credits: 0:0:1 (0+1)

Physical Education I

1. Teaching of skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
2. Teaching of different skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
3. Teaching of advance skills of Football – involvement of all the skills in game situation with teaching of rules of the game
4. Teaching of skills of Basketball – demonstration, practice of the skills, correction of skills, involvement in game situation
5. Teaching of skills of Basketball – demonstration, practice of the skills, involvement in game situation
6. Teaching of skills of Basketball – involvement of all the skills in game situation with teaching of rule of the game
7. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
8. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
9. Teaching of advance skills of Kabaddi – involvement of all the skills in game situation with teaching of rule of the game
10. Teaching of skills of Ball Badminton – demonstration, practice of the skills, correction of skills, involvement in game situation
11. Teaching of skills of Ball Badminton – involvement of all the skills in game situation with teaching of rule of the game

Physical Education II

1. Teaching of skills of Hockey – demonstration practice of the skills and correction.
2. Teaching of skills of Hockey – demonstration practice of the skills and correction. And involvement of skills in games situation
3. Teaching of advance skills of Hockey – demonstration practice of the skills and correction. Involvement of all the skills in games situation with teaching of rules of the game
4. Teaching of skills of Kho-Kho – demonstration practice of the skills and correction.
5. Teaching of skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of the skills in games situation
6. Teaching of advance skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of all the skills in games situation with teaching of rules of the game
7. Teaching of different track events – demonstration practice of the skills and correction.
8. Teaching of different track events – demonstration practice of the skills and correction with competition among them.
9. Teaching of different field events – demonstration practice of the skills and correction.

20AG2001 - RURAL AGRICULTURAL WORK EXPERIENCE (RAWE)

Credits 0:0:20 (0+20)

Introduction

The Honorable Prime Minister of India launched “Student READY” programme on 25th July 2015. The term “READY” refers to “Rural Entrepreneurship Awareness Development Yojana”. To reorient graduates of agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the programme as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

There are two components:

- I. **Rural Agricultural Work Experience (RAWE)**
- II. **Agro-Industrial Attachment and Plant Clinic (AIA)**

The Rural Agricultural Work Experience (RAWE) helps the students primarily to understand the rural situations, status of agricultural technologies adopted by farmers, prioritize the farmer's problems and to develop skills & attitude of working with farm families for overall development in rural area.

The students will undertake this program during the seventh/eighth semester for a maximum duration of 20 weeks with a weightage of 0+20 credit hours in two parts namely RAWE and AIA. RAWE will consist of general orientation and on campus training by different faculty members followed by village attachment/unit attachment in University/ College / KVK or a research station. Under AIA, the students would be attached with the agro-industries to get an experience of the industrial environment and working. Due weightage in terms of credit hours will be given depending upon the duration of stay of students in villages/agro industries. At the end of RAWE & AIA, the students will be given one week for project report preparation, presentation and evaluation. The students would be required to record their observations in field and agro-industries on daily basis and will prepare their project report based on these observations.

I. Rural Agricultural Work Experience (RAWE) - Credits: 0:0:16 (0+16)

Course Objectives:

To impart knowledge on

1. The socio-economic conditions of the farmers and their problems
2. Communication skills among students in using extension teaching methods for transfer of technology
3. The agro-industrial environment

Course Outcomes:

On completion of this course, students will be able to

1. Understand the agricultural ecosystem and farming systems
2. Acquaint themselves with farmers' problems and situations
3. Acquire knowledge on agricultural innovations through demonstrations and farmers training/ field day arranged with help of agriculture extension officers
4. Know the government, private and NGO rural development activities carried out in villages
5. Know the procedure of undertaking socio-economic studies
6. Remember agro-industrial operations

I. Agro-Industrial Attachment (AIA) - Credits: 4 (0+4)

Technology and globalization are ushering an era of unprecedented change. The need and pressure for change and innovation is immense. To enrich the practical knowledge of the students, in-plant training shall be mandatory for students for a maximum period of up to 3 weeks. In this training, students will have to study a problem in industrial perspective and submit the reports to the college. Such in-plant trainings will provide an industrial exposure to the students as well as to develop their career in the high tech agro-industrial requirements. In-Plant training is meant to correlate theory and actual practices in the industries and plant clinic system.

Course Content

Unit I: Rural Agricultural Work Experience (RAWE)

This unit enables the students to study of Village and Farm households (Agro-Ecological and Socio- Cultural Economic, Setting), particularly:

- Village settlement pattern, demography, climate, land utilization pattern, resources inventory, infrastructure facilities, rural institutions, organizations, groups, customs, beliefs and value systems.
- Study of cropping pattern, cropping systems, extent of adoption of latest technologies and constraints –cereals, millets, pulses, oilseeds and horticultural crops–productivity – Decline in productivity – Yield gap – constraints in production. Specific study on the following:
 - i. Agronomic Intervention.
 - ii. Plant protection Intervention.
 - iii. Soil Improvement Intervention.
 - iv. Fruit and Vegetable Production Intervention.
 - v. Food Processing and Storage Intervention.

vi. **Animal Production Intervention.**

- Understanding social participation, leadership pattern, scientific orientation and role of women and youth in agricultural development.
- Extension methods and Audio-visual Aids – Practicing individual, group and mass contact methods.
- Studying the existing Indigenous Technical Knowledge and its importance for technology generation.
- Understanding the communication pattern in villages.
- Studying farm women associations / farmers associations / commodity groups and learning their functioning and use of their services for dissemination.
- Conducting need-based skill demonstrations in the villages.
- Developing Whole Village Development Plan.
- Contacting individual farmers to assess the farming systems practiced by marginal, small, medium, big farmers and farm Women.
- Preparation of Individual farm plan.
- Documentation of success stories of the farmers.
- Study of University/College/KVK Research and Extension activities and Agricultural development schemes in the villages.

Unit II: Study of Agro-Industry & Plant Clinic

- Industries to be studied include seed/sapling production, pesticides- insecticides, post –harvests –processing –value addition, Agri-finance institutions, dairy, poultry, etc.
- General information about the Agro-Industry – Nature of business – Brief history of the firm - Licensing and other legal aspects of the firm.
- Study of structure, functioning, objective and mandates of the industry.
- Study of various processing units and hands-on trainings under supervision of industry staff.
- Employment generated by the industry.
- Contribution of the industry-promoting environment.
- Acquaintance with functioning of Plant clinics.
- Learning business network including outlets of the industry.
- Skill development in all crucial task of the industry.
- Documentation of the activities and task performed by the students.
- Performance evaluation, appraisal and ranking of students.

RAWE Components and Activities:

	Activity	No. of weeks*	Credit Hours
Preparation	General orientation & On-campus training by different faculty members	1	
RAWE	Village Attachment (including Extension center)	8	14
	Unit Attachment in Univ./college/ KVK, Research station & NGO	5	
	Plant Clinic Attachment	2	2
	Agro-Industrial Attachment	3	4
Evaluation	Project Report Preparation, Presentation and Viva-Voce	1	
	Grand Total	20	20

*As per ICAR V Dean Committee Report , P:76

Evaluation of student RAWE program

- i. Students shall be evaluated component-wise under village attachment/ agro-industrial attachment.

- ii. The university will designate a RAWE Program Coordinator who along with Mentor-teachers for the students groups would be become the committee of evaluators. While marking the performance, due weightage to the observations made by the Farmers/Agricultural Extension Worker / Scientists/Agro-industrial Officer and the Program Coordinator with whom they are attached will be given. The students will be evaluated for 100 marks. The outline of evaluation and distribution of marks will be as follows:

Components	Village Attachment	Extension Centre Attachment	Univ./KV K/Research Station /NGO Attachment	Agro-Industry & Plant Clinic Attachment	Total Mark
Participation, Oral Presentation and Work Diary maintained	30	10	10	10	60
Preparation Report	10	5	5	5	25
Overall Exhibition**					15
Total	40	15	15	15	100

**Final Display and Exhibition of learning outputs/findings/visuals/charts/posters/ Models before the Evaluation Committee

Note : Only one examination (End semester) will be conducted at end of the semester for 100 marks

iii. Performance during placement:

The committee led by the RAWE Coordinator and Mentor-teachers, who frequently visits /villages in rotation will assess the students' performance during the placements in villages. In case of placements in industries/institutions, the committee in consultation with the concerned designated person in the host institute will assign the marks for the performance of students.

iv. Group Presentation and Viva-voce:

After completion of student's placements in rural areas and institutions/industries, the Committee will have group discussion session to assess each student's level of participation and interaction abilities based on experience gained in RAWE. Each student along with the students group to which he belongs will give a brief presentation on the work that has been carried out, experience gained and points for future consideration. A Viva- voce examination will be conducted for each student on the relevant topics to know the overall impact of RAWE on the student, on the farming community and on the Institutions. Using the outputs and findings from various activities carried out in the filed programmes, the student groups shall put up a small exhibition/display to be seen, observed and scrutinized by the evaluation committee.

v. Attendance & diligence:

Marks are given for student's presence and attentiveness in classes conducted on the campus and placements in rural areas/institutions.

vi. Work diary:

Evaluation of work diary indicating brief description of activities carried out by the student every day during the placements.

vii. Practical record/Project report:

For each component, the student will maintain a practical record. The record will have detailed description for all the topics specified. The description will be on statement of tasks carried out, sequential steps/procedure followed in completion of the task, approaches used to accomplish the task, impact of the task on the intended audience, feedback obtained, and lessons learnt. For the

courses where placements in other institutions/industries are made, the student will write report with description on background of the institution as per topics given in the syllabus.

viii. Since the credit hours allotted to the RAWE program are grade-based, the minimum condition of attendance and grading system will apply for the program as will be applicable to other courses.

ix. It is expected that at the end of RAWE program, the students should gain familiarity and competency for working with rural stakeholders viz, Farmers, Development Departments, Agro-industries, NGOs and others. The evaluation committee must ensure percentage increase in this competency at the end & successful organization of all RAWE programs.

Monitoring & Coordination

For each batch, there will be a designated RAWE coordinator and concerned Mentor-teachers of the batch/student groups who will make periodical visits the rural- placement areas to guide, supervise and monitor the work of students as well as to evaluate the performance of the students on the concerned subject. They will also stay overnight once in a fortnight to support the students during the extension educational activities conducted during evening hours.

The RAWE coordinator in liaison with KVK/ZRS/NGO and other developmental departments will facilitate visit of Mentor-teachers to villages after the return of the students to ensure continued technical support to farmers, till the 'end of crop season. The Dean/ HoD of the college will provide necessary resources-material, finance, man power, vehicles, etc. and ensure participation of the designated Mentor- teachers in the RAWE activities. Coordination Committee for RAWE may consist of:

- i. Dean of the Faculty- Chairman
- ii. HOD, Agriculture- Convener
- iii. Senior Teacher of Extension Education- RAWE Coordinator
- iv. Student Counselor/Mentor- Member
- v. Representative of State Dept. of Agriculture (AO) :- Member
- vi. Village Leader / Farmer (off-campus representation. (1) - Member
- vii. Agro-industry Representative-Member
- viii. Group Facilitator (Student representatives)- Member

Other General Guidelines:

- A mid-term appraisal will be taken up by the Heads of Departments and the Evaluation Committee for reviewing the work carried out by the students.
- Periodical visits will have to be made by Evaluation Committee members to the locations to monitor, guide and supervise the students.
- An exhibition will be conducted highlighting the experiential learning process, depicting the outcomes, supported with charts, posters, specimens, models, etc., on completion of the programme.
- Mass media coverage may be given for the different activities undertaken by the students. Local prominent persons may be invited for RAWE programmes in villages.
- Appropriate documentation has to be ensured at all stages. Photographs/video coverage and newspaper messages should be ensured and arranged in possible locations/events.

Instructions to students

- No student should leave the location during this period on any account even during holidays.
- A movement register will have to be maintained indicating the date, time, places, purposes of visit and expected time of arrival.
- Students while leaving for respective villages/Agriculture Dept office/Industry should leave a message about their programme in the movement register maintained for this purpose where they are staying.
- They should maintain an observation note for recording on the spot details during their visits to record daily activities and programmes.
- All the students will be given a Practical Manual for which the details should be collected

during the course of the programme.

- On reaching the location of their stay, all students should intimate the Head of the Department / RAWE Coordinator and Mentor-Teacher about their arrival.
- The RAWE Coordinator and Mentor-Teachers will guide the students about the villages identified for each student and details of the place of stay.
- The Group Facilitators will guide the students in the selection of NGO, ADA office, and Agro-Industry for each group in and around the location.
- All students should report to the Professor and Head, Department of Agriculture, RAWE-Coordinator and Mentor-Teachers and the Group Facilitators about the particulars regarding the villages allotted to them, the names and addresses of the contact farmer in the villages and work carried out every week.
- Students should avoid unnecessary exchange of ideas with the local people on politics, religion, caste, etc., which will spoil the harmony of programme.
- Students should contact maximum number of farmers in the locality and participate in the farm operations and record the observations about marginal, small and big farmers and one farm woman.
- Students should avoid doing anything which may damage the image of students, as well as students institution.
- Head of the Department of Agrl, RAWE Coordinator and Mentor -Teachers will make surprise inspection to know the students activities.
- In case of emergency, students may contact Professor and Head, Department of Agricultural/ RAWE Coordinator/ Mentor-Teachers.
- The mobile numbers of Group facilitators may be obtained by students.
- The students should keep in readiness their observation note and Practical Manual for evaluation on the final day of RAWE.

References:

1. ICAR Fifth Deans Committee Report, Agricultural Education Division, Indian Council of Agricultural Research (ICAR), New Delhi.
2. Academic Information Hand Book, 2019, KITS, Coimbatore.
3. RAWE manual, guidelines of TNAU, Coimbatore.
4. Personal discussion with TNAU experts and brain storming contribution from Agri. Faculty of KITS.

20AG2002 - EXPERIENTIAL LEARNING PROGRAMME (ELP)

Credits: 0:0:20 (0+20)

Experiential Learning Programme (ELP) provides the students an excellent opportunity to develop analytical and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and execute project work.

Students' Eligibility

To get the eligibility for registering for the EL programme, the students should have completed all the courses successfully. No student should be allowed to take up the EL programme with backlog/repeat courses. The assignment/allotment of the EL programme shall be based on merit of the student at the end of 5th semester. A separate certificate should be issued to the students after successful completion of ELP course. Allotment of EL programmes amongst students to different modules should be done strictly on the basis of merit at the end of fifth semester.

Duration

The experiential learning programme will be offered for 180 days (one semester) period in the final year. As the programme is enterprise oriented, students and faculty are expected to attend the activities of the enterprise even on institutional holidays with total commitment, and without any time limit or restriction of working hours for ELP. The Experiential Learning Programme shall be run for full year by making groups and rotating activities of the final year in two groups.

Attendance

The minimum attendance required for this programme is 85%. The attendance of a student will be maintained at the EL unit. The attendance particulars shall be communicated to the Chief Executive Officer (Associate Dean) by the Manager of the EL unit every week. The students will be eligible for the final evaluation of EL only when the attendance requirement is met with. Any student in the event of recording shortage of attendance has to re-register the EL when offered next by paying the assigned fee.

This program will be undertaken by the students preferably during the eighth semester for a total duration of 24 weeks with a weightage of **0:0:20** credit hours. The students will register for any of two modules, listed below, of **0:0:10** credit hours each.

ELP Module No	ELP Title
ELP 01	Seed Production and Technology
ELP 02	Soil, Plant, and Water testing
ELP 05	Organic Production Technology
ELP 09	Floriculture and Landscaping
ELP 12	Nursery Management and Protected Cultivation
ELP 13	Production Technology for Bioagents and Biofertilizer
ELP 14	Mushroom Cultivation
ELP 15	Bee keeping
ELP 17	Agribusiness management
ELP 19	Agricultural Information Support Services
ELP 22	Poultry Production Technology

Evaluation of Experiential Learning Programme for B.Sc. (Hons.) Agriculture & Horticulture.

S.No.	Parameters	Max. Marks
1.	Project Planning and Writing	10
2.	Presentation	10
3.	Regularity	10
4.	Monthly Assessment	10
5.	Output delivery	10
6.	Technical Skill Development	10
7.	Entrepreneurship Skills	10
8.	Business networking skills	10
9.	Report Writing Skills	10
10.	Final Presentation	10
	Total	100

**As per the ICAR V Deans Committee Report.*

Sharing of Profits and Losses

The entire scheme of experiential, wherever appropriate, would follow the already established system of “earn while you learn”. In such programmes, a proper system of accounting would be followed and maintained and managed by the students. Net profits generated by each group of the trainees will be shared as follows.

- Team Members (trainees) take away 50% of the profits.
- Faculty (associated with the conduct of the programmes) shares 10% of the profits.
- Central Training Fund of the University gets 20% of the profits.
- Associated staff shares 10% of the profits.
- Remaining 10% of the profits would be used for development of facilities and replacement of old facilities.

Losses if any will be borne by the “Central Training Fund”. Any loss-making unit will be subjected to thorough scrutiny by a team of experts and recommendations will be drawn for future corrective measures to minimize recurrence of losses.

(As per the Guidelines for Experiential Learning - Setting up of Facilities for Hands on Training)

ELP01 - SEED PRODUCTION AND TECHNOLOGY

Planning of seed certification procedures, application for seed license, preparation of field map for registration and field layout, assessment of seed source, designing of planting ratio, seed upgradation, visit to seed certification department, sowing, field inspection, rouging operations, foliar application of nutrients, pollen management and assessment of seed set, visit to seed production plot. Pre-harvest sanitation spray, determination of maturity, harvesting, post harvest verification, preparation of processing report. Drying, processing sequence, application for getting approval of seed processing unit, sampling and submission of samples, pre-storage seed treatments and packing, tagging, economics of seed production, visit to seed testing laboratory for seed testing, visit to private seed industry to study seed marketing network, seed export and import.

References

1. Agrawal, R.L. 2012. Seed Technology, Oxford & IBH Publishing Co., New Delhi.
2. Trivedi, R.K. and M. Gunasekaran. 2013. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.
3. Ramalingam, C., K. Sivasubramaniam and A. Vijayakumar. 1997. A guide to seed legislation. Rasi Computers, Madurai.

ELP02 - SOIL, PLANT AND WATER TESTING

Collection and preparation of soil, plant and irrigation water samples (sampling, processing and storing), estimation of pH, EC, organic carbon, available Nitrogen, Phosphorus, Potassium and micronutrients – available Fe, Mn, Cu and Zn in soil, inferring the results and evaluating the fertility status of the soil.

Plant sample preparation for analysis, digestion of plant material and estimation of Nitrogen, Phosphorus and Potassium in plant. Determination of pH, EC, Carbonate and Bicarbonate, calcium, magnesium, sodium and potassium content in irrigation water. Computation of irrigation water quality class, Residual Sodium Carbonate and Sodium Absorption Ratio of Irrigation water and evaluating the suitability of irrigation water.

Reference

1. Black, C.A. 1982. Methods of Soil Analysis, Part I ASA, Madison, USA.
2. Havlin, John L., Tisdale, Samuel L., Nelson, Werner L., and Beaton James D. 2013. Soil Fertility and Fertilizers: An Introduction to Nutrient Management, 8th Edition, Pearson Education Inc., USA.
3. Hesse, P.R. 2002. A Textbook of Soil Chemical Analysis, CBS Publishers and distributors, Delhi
4. Muthuvel, P. and C. Udayasoorian. 1999. Soil, plant, water and agrochemical analysis, Tamil Nadu Agricultural University, Coimbatore, India.

ELP03 - ORGANIC PRODUCTION TECHNOLOGY

Principles of composting. Various methods of composting. Characterization and preparation of quality compost material. Study of earthworms and methods of vermicomposting - Preparation of bio-compost. Enriched compost and ITK based biological preparations. Visit to compost/vermicompost production unit. Preparation and use of bio-pesticides and bio-control agents. Quantification of nutrients from organic sources. Keeping quality - Application methods of manures and bio-fertilizers. Toxic residue analysis. Visit to bio-pesticides and bio-control production unit. Raising organic nursery and green manures for agricultural crops - Raising of crops organically by using organic inputs. Weed management – Nutrient management. Pest and disease management. Grading, packaging, post-harvest management and certification process. Visit to organic farms, organic farming outlets and certification agencies to study the standards & certification process.

References

1. Palaniappan S.P and K.Annadurai. 2018. Organic Farming: Theory and Practice. Scientific Publishers, Jodhpur, India.
2. Sharma A.K.. 2008. Hand book of Organic Farming. Agrobios, India.
3. Panda H.. 2007. Biofertilizers and Organic Farming. Gene-Tech Books.
4. Parvatha Reddy P. 2010. Organic farming for sustainable Horticulture. Scientific Publishers, Jodhpur, India.
5. Tarafdar J.C., K. Tripathi and M. Kumar. 2009. Organic Agriculture. Scientific Publishers, Jodhpur, India.

ELP04 - FLORICULTURE AND LANDSCAPING

Scope and importance of commercial floriculture in India. Preparation of land and layout. Production techniques of commercial flower crops for domestic and export market. Principles of protected structures – poly house – net house – shade net house. Growing of commercial flowers under protected structures. Postharvest technology of cut and loose flowers. Transportation for local and export market. Study of supply chain management and cold storage techniques. Dehydration techniques for drying of flower (identification of suitable species, drying and packaging). Making of different flower arrangements. Principles of landscaping- Study of different types and styles of gardens. Designing and planting for establishing different landscape gardens. Use of Autocad for designing gardens of different environments. Visit to different landscape like public, institutional, industrial and botanical gardens. Preparation of cost analysis.

References

1. Tiwari A.K. and R. Kumar. 2012. Fundamentals of ornamental horticulture and landscape gardening, New India Publishing Agency, Delhi
2. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana
3. Bose, T.K. R.G. Malti, R.S. Dhua and P. Das. 2004. Floriculture and Landscaping. Nayaprakash, Calcutta
4. Grewal H. S. and P. Singh. 2014. Landscape designing and ornamental plants. Kalyani publishers, New Delhi
5. De. L.C 2013. Nursery and landscaping. Pointer publishers, Jaipur, India
6. Roy R.K. Fundamentals of Garden designing. 2013. New India publishing agency, Pitampura, New Delhi
7. Srivastava R. 2014. Fundamentals of Garden designing. Agrotech press, Jaipur, India.

ELP05 - NURSERY MANAGEMENT AND PROTECTED CULTIVATION

Nursery production of fruit crops: Raising of rootstocks, grafting and budding of rootstocks, management of grafted plants, plant certification, packaging and marketing, quality control. Nursery production of ornamentals: Production of plantlets, production of potted plants, management and maintenance, sale and marketing. Protected cultivation of vegetables and flowers: Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing. Visit to commercial polyhouses, project preparation and planning. Specialized lectures by commercial export house. Study of designs of green- house structures for cultivation of crops. Land preparation and soil treatment. Planting and production: Visit to export houses; Market intelligence; Marketing of produce; cost analysis; Visit to export houses; Institutional management. Report writing and viva-voce.

References

1. Sadhu, M.K. 1989. Plant Propagation. Wiley Eastern Ltd., New Delhi
2. Bose, T.K., S.K. Mitra, M. K. Sadhu and B. Mitra. 1991. Propagation of Tropical and Subtropical Horticultural crops. Naya Prakash Publishers, Culcutta, India.
3. Hartmann, H.T., D. E. Kester, F.T. Davies and R. L. Grene. 2010. Plant Propagation – Principles and Practices. Prentice Hall of India Private Ltd., New Delhi.
4. Nanda, K. K and V. K. Kochhar. 1995. Vegetative Propagation of Plants. Kalyani Publishers, Ludhiana.

5. Prasad, S. and U. Kumar. 2005. Green house management for horticultural crops. 2nd ed. Agrobios.
6. Resource book on Horticulture Nursery Management, National Agricultural Innovation Project, Indian Council of Agricultural Research, New Delhi.-110012.
7. Tiwari, G.N. 2003. Green house technology for controlled environment. Narosa Publ. House.
8. P. Ratha Krishnan (ed.). 2014. Plant nursery management: Principles and practices, Central Arid Zone Research institute, ICAR. Evergreen Printers, Jodhpurs

ELP 06 - PRODUCTION TECHNOLOGY FOR BIOAGENTS AND BIOFERTILIZER

Rearing of host insect *Corcyra cephalonica*. Rearing of egg parasitoid- sterilizing the host eggs and parasitization, Tricho card preparation and storing. Rearing of larval parasitoid *Bracon* and *Goniozus nephandidis* – sandwich method. Mass production of predator *Chrysoperla carnea*. Isolation, characterization, screening and pure culture establishment of bio-fertilizers and bio-pesticides. Commercial mass production of bio-fertilizers and bio-pesticides. Quality analysis of bio-fertilizers and bio-pesticides. Testing the final product in small-scale level. Storage, marketing and cost analysis of bio-fertilizers and pesticides

References

1. Burges, H.D. 1981. Microbial control of pests and plant diseases, Academic Press, New York.
2. Clausen, C.P. 1940. Entomophagous insects. Hafner Publishing Co. New York.
3. DeBach. P. and E.T. Schlinger (eds.). 1964. Biological control of insect pests and weeds. Chapman and Hall, London.
4. Puri, S.N., K.S. Murthy and O.P. Sharma. 1997. Resource Inventory for Integrated Pest Management – I. Information Bulletin No. 3. National Centre for Integrated Pest Management (Indian Council of Agricultural Research), New Delhi
5. Garret, S.D. 1977. Pathogenic root infecting fungi. Cambridge unit press, Cambridge, p.294.
6. Hornby, D. 1990. Biological control of plant pathogens. Oxon, United Kingdom, CAB International, p.479.
7. Huffaker, C.B. (ed.) 1974. Biological control, Plenum Publishing Corporation. United States of America.
8. Puri, S.N., K.S. Murthy and O.P. Sharma. 1997. Resource Inventory for Integrated Pest Management – I. National Information Bulletin No.3.

ELP07 - MUSHROOM CULTIVATION TECHNOLOGY

Students will learn the facilities required for construction of mushroom shed -cultivation room/structure and disinfection, maintenance of aseptic condition. Learn cultivation techniques for oyster mushroom - Procurement of mother culture and spawn preparation - sterilization of straw- bed preparation – Mushroom seeding – moisture maintenance -Harvesting - Learn cultivation techniques for Milky mushroom, Compost preparation & pasteurization - Procurement of mother culture and spawn preparation -Procurement of casing soil and preparation for production -Mushroom seeding - Casing with soil and maintenance –Harvesting -Visits to commercial mushroom production unit- Value added processing - Grading, packing - marketing and Cost economics of mushroom culture.

References

1. Agarwal, R.K. and C.L.Jandaik.1986. Mushroom cultivation in India. Indian Mushroom Growers Association, Solan, Himachal Pradesh.p-83.
2. Bahl, N.1988. Hand book of Mushroom II Edn. Oxford & IBM Publishing Co. New Delhi.
3. Marimuthu, T., A.S Krishnamoorthy, K.Sivaprakasam and R.Jeyarajan, 1989.Oyster Mushroom Production. The Vijay Books.Sivakasi, India.P.57.
4. Krishnamoorthy, A.S., Marimuthu, T., and S. Nakkeran. 2005. Mushroom Biotechnology ,The Vijay Books. Sivakasi, India.,Pub.ODL, TNAU, Cbe-3
5. Pathak,V.N. N.Yadav and M Gaur.2000.Mushroom production and processing Technology. Agribios (India) Ltd., New Delhi

ELP08 - BEE KEEPING

Familiarization with different honey bee species and different castes - Handling of frames with colonies- Identification of bee flora - Propagation of bee plants - Preparation of floral calendar - Hiving feral Indian bee colony, site selection for apiary- Visit to migratory bee keeping sites and commercial *cerana* bee farm- visit to manufacturing unit (Marthandam)- visit to beekeeping society- Visit to honey processing unit.Colony inspection, maintenance - writing up of inspection report –Identification of queen, drone and brood cells- Sugar feeding of colonies in scarcity period- Identification of swarming tendency in a colony - Removal of Drone cells - maintenance of hive record-Management in honey flow season, dearth period, management of swarming absconding and laying workers-Practicing the methods of multiplication of bee colonies- Dividing, uniting bee colonies- Disease management - Identification of symptoms of Nosema. Sac brood Virus, Thai sac brood virus, American foul brood and European foul brood diseases - Preventive and control measures of the diseases- Application of antibiotics to colonies –Practicing the disinfection of frames - Natural enemies and predators of Honey Bees and their management.Migratory Bee Keeping - measures to be taken while transporting colonies-Mapping of areas for migration- Extraction of Honey using Honey extractor, moisture reduction, packing and storing of Honey- Methods of Extraction of Bees wax, Royal Jelly and Bee venom-Marketing and working out of economics of honey and bee products- Preparation of bee keeping and honey processing unit project proposal to a bank or government authorities- Honey testing kit - Physical and chemical methods of analysis - Visit to AGMARK laboratory.

References

1. Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Books.
2. Abrol, D.P. 2011. Beekeeping- A comprehensive guide to bees and beekeeping. Scientific publishers. Jodhpur.
3. SuganyaKanna, S., T. Senguttuvan and P. Karthik. 2019. Management of beneficial and harmful insects. Guru publishers, Trichy.
4. David Cramp, 2012. The Complete Step-by-step Book of Beekeeping: A Practical Guide to Beekeeping, from Setting up a Colony to Hive Management and Harvesting the Honey. Lorenz Books. London.

ELP 09 - AGRI BUSINESS MANAGEMENT

Students will learn about Agribusiness landscape in India – (Economic –Political – Institutional Ecosystem for Agribusiness). Hands-on experience in conducting market survey to gain understanding on working out consumer profile, competitors, substitutes and their price, and features, and designing market strategy (off-campus). Students will interact with staff / experts for mid-term corrections and submission of interim report (on campus). Students will acquire practical knowledge on forecasting market demand, pricing methods, creating and organizing advertising campaigns (facebook ads, twitter ads, etc.). Product management: Various packaging materials used for agro-based products, product distribution network, marketing cost and marketing planning process (off-campus). Practical knowledge will be given on Management of Agro-Inputs by Marketing Firm-Visit, Government Institutional visits. Hands-on experience in commodity trading, marketing research and devising marketing strategies (app development), information system for new product development, options for extending product life cycle, and spot and online marketing (social media marketing via Youtube, Facebook, Twitter, Instagram, and Pinterest), Business Law and Ethics, and Export-import policies followed by agriculture marketing firms (off-campus). Preparation of a model project proposal (On-campus). Preparation of Financial Statements- Balance Sheet, Income statement, and cash flow statement.

References:

1. Raju, V.T. and D.V.S. Rao. 2014. Economics of Farm Production and Management. Oxford and IBH Publishers, New Delhi
2. Dewett, K.K. 2005. Modern Economic Theory. S. Chand publishers, New Delhi.
3. Sharma, Pawan, Dwivedi, Sudhakar and Anil. 2014. Practicals in Agricultural Economics, Daya Publishing House, New Delhi.

- Patil J. V., H.R. Shnide, Chavan, and P.P. Pawan. 2015. Key Notes on Agricultural Economics, Business management and statistics, Astra e-book publication.

ELP10 - AGRICULTURAL INFORMATION SUPPORT SERVICES

E-Agriculture and Use of ICT in Agriculture- practical applications, Online Agriculture Support Systems, online advertising and marketing tools, Smartphone Apps in Agriculture for farm advisor services, market price, postharvest management etc., Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System.

References

- Dent J.B. 1979. Systems Simulation in Agriculture. Applied Science Publishers Ltd, London, U.K
- Joe. J. Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
- Lyn. Malone, Anita M. Palmer, Christine L. Vloghat and J. Dangeermund. 2002. Mapping out world: GIS lessons for Education. ESRI press.
- Mahapatra SK. et al., 2019. Introductory Agri- Informatics. Jain Brothers, New Delhi
- Oliver M. A. 2010. Geospatial Applications for Precision Agriculture Springer Publishers, London, U.K.
- Pedersen S.M. and K.M. Lind, 2017. Precision Agriculture: Technology and Economic Perspectives. Springer Publishers, UK.
- Stafford J. V. 2007. Precision Agriculture '07. Wageningen Academic Publishers, The Netherlands.
- Vanitha G and M. Kalpana, 2011, Agro-Informatics. New India Publishing Agency, New Delhi
- Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
- Handbook of Agriculture, 2018, ICAR, New Delhi.

ELP 011 - POULTRY PRODUCTION TECHNOLOGY

Project preparation and planning based on visit to commercial broiler and layer farms. Preparation of project module based on source of finance, market information, assessment of fixed and working capital requirements, identification of sources for procurement of chicks, feed and other raw materials. Setting up a broiler / layer farming unit with suitable necessities. Planning and execution of management practices of poultry farm viz. Site selection and preparation of poultry house, Different housing regimes, Fumigation, Incubation, Brooding, Debeaking and sanitation, Hatching of eggs, Management of chicks, Management of pullets and growers, Management of layers, Management of broilers, Selection and culling, Feed and feed formulation, Prevention and control of diseases, Medication and vaccination, Biosecurity measures, Processing of broilers, Evaluation of egg for its quality, Record maintenance, Integration method of broilers marketing, Marketing channels in broilers and layers. Economics of broiler and layer farming.

References

- Banerjee, G.C. 2018. The Text Book of Animal Husbandry. Oxford Book Company, Calcutta.
- Handbook of Animal Husbandry. 2002. ICAR, New Delhi.
- Sabel Guerrero-Legarreta. 2010. Handbook of Poultry Science and Technology. John Wiley & Sons, New York
- Vegad J. L. 2018. Poultry Diseases A Guide for Farmers and Poultry Professionals. CBS Publishers & Distributors Pvt Ltd., New Delhi.
- Weeks, C and A. Butterworth. 2004. Measuring and auditing broiler welfare. CABI Publishing, Oxford, U.K
- Diseases of Poultry, 13th Edition, David E. Swayne (Editor-in-Chief), Wiley India Pvt. Ltd, New Delhi.
- Burr Charles T. and H.O Stuart. 2011. Commercial Poultry Farming. Biotech Books India, New Delhi.

Journals

1. Satapathy D., A. Sharma, J.K. Paswan, S. Sarkar and T.K. Varun. 2017. Economic Broiler Framing: Scope and Limitations. Indian Farmer, 4(5), pp. 393-405.
2. Singh, A.K., M.P., Sagar and M. Chander. 2017. Constraints in Contract and Non-contract Broiler Farming Systems in Eastern Plain Zone of Uttar Pradesh. The Indian Journal of Veterinary Sciences and Biotechnology, 12, pp. 39-41.
3. Kumar R.K., G.R. Manjunatha and B. Chandra. 2017. Economic performance of Contract Broiler Farming. Indian Journal of Poultry Science, 52(2), pp. 217-221.
4. Karthikeyan, R. and V.R. Nedunchezian. 2013. Vertical integration paving way to organized retailing in Indian poultry industry. International Journal of Business and Management Invention 2(1): 39-46.
5. Sridharan, A. and R. Saravanan. 2013. A Study on motivating factors to enter into poultry farming with special reference to Suguna broiler contract farms in Coimbatore district. International Journal of Marketing, Financial Services & Management Research 2(4):109

20AG2003 - ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS COMMUNICATION **Credit: 1:0:1 (1+1)**

Course Objectives:

To impart knowledge on

1. Entrepreneurial spirit and orientation towards becoming an entrepreneur
2. Agri-business opportunities that are commercially successful and the procedures involved in start-ups
3. The art and science of business plan and project formulation

Course Outcomes:

On completion of this course, students will be able to

1. Distinguish different entrepreneurial traits and skills
2. Know the agribusiness opportunities open for agriculture graduates
3. Apply the leadership skills to get financial support for start-ups
4. Understand the impact of economic reforms in agri-business
5. Perform SWOT analysis of an entity for any prospective agribusiness/ideas
6. Formulate business proposals for successful implementation of business plans

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation. Government policy, programs, and institutions for entrepreneurship development. Impact of economic reforms on Agribusiness/ Agri-enterprises, Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring and evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for Agri entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem-solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea. Preparation of business plan and proposal writing. Visit to local rural enterprise engaged in agribusiness (Agri out based based), Visit to local rural enterprise engaged in agribusiness (Agri input based) Art of raising fixed and working capital for the business - Interaction with bank managers funding entrepreneurs and agribusinesses. Visit to entrepreneurship development institute and studying their promotional activities.

Reference Books

1. Chopra, R.R., P.S. Kapse and P.R. Deshmukh. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur, India.
2. Singal, R.K. 2006. Entrepreneurship Development and Management. S. K. Kataria and sons, New Delhi, India.

3. Nandan, H. 2013. Fundamentals of Entrepreneurship. PHI publishers, New Delhi, India.
4. Sangeeta Sharma, 2016. Entrepreneurship Development. PHI Publishers, New Delhi.
5. Heady Earl, O and H. R. Jenson. 1954. Farm Management Economics. Prentice Hall, New Delhi.
6. Johl, S.S. and J.R. Kapur. 2006. Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi.
7. Karan Singh and A S. Kahlon 1981. Economics of Farm Management in India. Theory and Practice. Allied Publishers Pvt. Ltd, New Delhi.
8. Prasad. L.M. 2001. Principles and Practices of Management. 9th Ed. S. Chand and Sons, New Delhi.
9. Koontz Harold and Weihrich, Heinz, 2007. Essentials of. Management. Tata McGraw Hills, Education Private Limited, New Delhi.

20AG2004 - COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Structural and functional grammar.
2. Writing and oral presentation skills
3. Group presentations and group discussions

Course Outcomes:

On completion of this course, students will be able to

1. Apply indexing, footnote and bibliographic procedures
2. Understand the comprehension of articles.
3. Summarize and abstract.
4. Participate and organize group discussions and seminars
5. Develop listening, writing and oral presentation skills
6. Maintain field diary and lab record

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations.

References

1. Balasubramanian T. 1989. A Textbook of Phonetics for Indian Students. Orient Longman, New Delhi.
2. Balasubramanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
3. Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
4. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
5. Krishnaswamy, N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
6. Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
7. Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.

20AG2005 - PRACTICAL CROP PRODUCTION-I (KHARIF CROPS)

Credits 0:0:2 (0+2)

Course Objectives:

To impart knowledge on

1. Practical cultivation practices of *kharif* crops
2. The phenological phases and its significance of each phase in crop production
3. Calculation and estimation of yield and other parameters influencing crop yield

Course Outcomes:

On completion of this course, students will be able to

1. Demonstrate practical cultivation of *kharif* crops
2. Identify problems in *kharif* cultivation and to offer solutions
3. Suggest marketing channels for products of cultivation
4. Operate modern farm equipment
5. Optimize resource utilization and recommend package of practices for *Kharif* crops
6. Construct a balance sheet showing cost of cultivation and net income generated

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students. Important kharif crops like rice and maize will be raised.

Reference Books

1. Rajendra Prasad. 2006. Text book of field crops, ICAR, New Delhi
2. Mukund Joshi. 2015. Text book of field crops, PHI Learning Private Ltd., New Delhi
3. Chidda Singh. 1997. Modern techniques of raising field crops, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi
4. Crop Production Guide Agriculture. 2020. Directorate of Agriculture & Tamil Nadu Agricultural University

20AG2006 - PRACTICAL CROP PRODUCTION-II (RABI CROPS)

Credits 0:0:2 (0+2)

Course Objectives

To impart knowledge on

1. Practical training on cultivation practices of *rabi* crops
2. Phenological phases and significance of each phase in crop production
3. Estimating yield and other parameters influencing crop yield

Course Outcomes

On completion of this course, students will be able to

1. Understand cultivation practices of *rabi* crops
2. Identify problems related to *rabi* crop production and offer solutions
3. Suggest marketing channels for products of cultivation
4. Operate modern farm equipment
5. Optimize resource utilization and recommend package of practices for *rabi* crops
6. Construct a balance sheet with inputs of cultivation costs and net income generated

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students. Important Rabi crops like sunflower will be raised.

Reference Books

1. Rajendra Prasad, 2006, Text book of field crops, ICAR, New Delhi
2. Mukund Joshi, 2015, Text book of field crops, PHI Learning Private Ltd., New Delhi
3. ChiddaSingh, 1997, Modern techniques of raising field crops, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi
4. Crop Production Guide Agriculture. 2020. Directorate of Agriculture & Tamil Nadu Agricultural University

20AG2007 - GEOINFORMATICS AND NANOTECHNOLOGY AND PRECISION FARMING

Credit 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of GIS, GPS and drones in agriculture
2. Sensors and its application in agriculture
3. Crop simulation models and their role in precision farming

Course Outcomes

On completion of this course, students will be able to

1. Understand the concept of precision farming
2. Relate the use of GIS and GPS systems in drip installation and fertigation techniques
3. Demonstrate use of Unmanned Aerial Vehicle (UMAV) to gather information
4. Develop precision farming technology for important crops.
5. Analyse applications of sensors in agriculture
6. Apply Crop Simulation models and Site Specific Management using Geo referencing

Theory

Precision farming - introduction - concept and importance; Tools - Role of GIS and GPS – Un Manned Aerial Vehicle (UMAV) - Mobile mapping system and its application in precision farming; Design layout and installation of drip and fertigation; Site specific management (SSM) - geo-referencing and photometric correction; Sensors - information gathering and application; Crop simulation models - role in precision farming. Precision farming technology- crops -cotton - banana and tomato.

Practical

Estimation of material requirement for construction of greenhouse ; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques;; crop simulation models; Design - layout and installation of drip and fertigation techniques

References

1. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
2. Nelson, P.V. 1991. Green house operation and management. Ball publishing USA.
3. Ancha Srinivasan. 2006. Hand book of precision agriculture principles and applications. The Haworth press. Binghamton. Inc., New York.
4. Zhang Q, 2015. Precision Agriculture Technology for Crop Farming, Taylor & Francis.
5. Rattan Lal and B.A..Stewart. 2015. Soil specific farming-Precision Agriculture. CRC Press, American Publishing group.
6. Qin Zhang. 2015. Precision Agriculture Technology for crop farming. CRC Press, American Publishing group.
7. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
8. Adams, C.R. K.M. Band ford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Daryaganj, New Delhi.
9. Lyn. Malone, Anita M. Palmer, Christine L. Vloghat, and J. Dangermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
10. David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA

20AG2008 - FUNDAMENTALS OF PLANT BREEDING

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Genetic diversity, inheritance and variation in crops
2. Different breeding methods in autogamous, allogamous and asexually propagated crops
3. Intellectual property rights, patenting, plant breeders and farmers rights.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic concepts of plant breeding and genetics.
2. Remember Origin and diversity of different crops, components of inheritance and variations
3. Apply the knowledge to develop high yielding crops with better quality
4. Produce varieties and hybrids with Host Plant resistance
5. Apply the protocols of Intellectual Property Rights and Patenting practically.
6. Analyse Plant Breeders and & Farmer's Rights for research and commercial seed production of high yielding crops

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility- genetic consequences, cultivar options. Domestication, acclimatization and introduction; centres of origin/ diversity, components of genetic variation; heritability and genetic advance; genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; multiline concept. Concepts of population genetics and hardy-weinberg law, genetic basis and methods of breeding cross-pollinated crops, modes of selection. Population improvement schemes- ear to row method, modified ear to row, recurrent selection schemes; heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; breeding methods in asexually propagated crops, clonal selection and hybridization; maintenance of breeding records and data collection; wide hybridization and prebreeding; polyploidy in relation to plant breeding, mutation breeding-methods and uses; breeding for important biotic and abiotic stresses; biotechnological tools- dna markers and marker assisted selection. Participatory plant breeding; intellectual property rights, patenting, plant breeders and & farmer's rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and cross-pollinated crops. Emasculation and hybridization techniques in self and cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

Reference books

1. Acquaah, G. 2007. Principles of Plant Genetics & Breeding. Blackwell Publishing Co., New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Gupta, S. K. 2005. Practical Plant Breeding. Agribios, Jodhpur.
5. Roy, D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House Pvt. Ltd., New Delhi.
6. Sharma, J. R. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing Co. Pvt. Ltd., New Delhi.
7. Simmonds, N.W. and J. Smartt. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
8. Singh, B. D. 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana.
9. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.

10. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.
11. Singh, P. and Narayanam, S. S. 2009. Biometrical Techniques in Plant Breeding (4th Ed.). Kalyani Publishers, Ludhiana.
12. Singh, S. and Pawar, I. S. 2006. Genetic Bases and Methods of Plant Breeding. CBS Publishers, New Delhi.

20AG2009 - PRODUCTION TECHNOLOGY OF VEGETABLES AND SPICES

Credits 1:0:1 (1+1)

Course Objectives

To impart knowledge on

1. Importance of vegetable and spices cultivation and prominent vegetables and spices in India.
2. Production technology of tropical vegetable and spice crops.
3. Plant protection measures in vegetable and spice crops.

Course Outcomes:

On completion of this course, students will be able to

1. Appreciate the role of vegetables and spices in human nutrition and national economy.
2. Follow scientific agronomic practices in producing tropical vegetable and spice crops.
3. Control pest, diseases, weed and physiological disorders in tropical vegetable and spices crops.
4. Create and maintain kitchen garden and spices.
5. Understand the harvesting methods of vegetable and spice crops.
6. Apply post-harvest technology in vegetable and spice crops

Theory

Importance of vegetables and spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas; Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic; Root crops such as Carrot, Raddish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables).

Practical

Identification of vegetables & spice crops and their seeds. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables & spices. Fertilizers applications. Harvesting & preparation for market. Economics of vegetables and spices cultivation.

References

1. Gopalakrishnan, T.R., 2007. "Vegetable Crops" New India publishing agency, New Delhi.
2. James S. Shoemaker and Thomas Smith., 2006. "Culture of Veg., Growing" Asiatic.
3. Neeraj Pratap Singh. 2005. "Basic concepts of vegetable science", International Book distributing co., New Delhi.
4. Pranab Hazra, A. Chattopadhyay, K. Karmakar and S. Dutta. 2010. "Modern technology in vegetable production" New India Publishing Agency, New Delhi.
5. Vishnu Swarup, 2006. Vegetable science and technology in India. Kalyani publishers, New Delhi.
6. Uma Shankar Singh, 2008. "Indian vegetables", Anmol publications Pvt., Ltd., New Delhi.
7. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
8. Jitendra Singh. 2008. Spices and Plantation Crops. Aavishkar Publishers, Distributors, Jaipur.

20AG2010 - PRODUCTION TECHNOLOGY FOR ORNAMENTAL CROPS, MAP AND LANDSCAPING

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Production technology of cut flowers, ornamental crops, MAP and turf management
2. Landscape use of trees, shrubs and climbers
3. Styles of landscape gardening and post-harvest handling of flower crops

Course Outcomes:

On completion of this course, students will be able to

1. Apply production technology of cut flowers, MAP and ornamental crops
2. Establish lawns and manage turf
3. Apply principles of landscaping using trees, shrubs and climbers
4. Design different styles of gardens
5. Handle flower crop harvesting and post-harvest operation and processing of MAPs
6. Perform training and pruning of ornamental plants

Theory

Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, lily and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Processing and value addition in ornamental crops and MAPs produce.

Practical

Identification of Ornamental plants. Identification of Medicinal and Aromatic Plants. Nursery bed preparation and seed sowing. Training and pruning of Ornamental plants. Planning and layout of garden. Bed preparation and planting of MAP. Protected structures – care and maintenance. Intercultural operations in flowers and MAP. Harvesting and post-harvest handling of cut and loose flowers. Processing of MAP. Visit to commercial flower/MAP unit.

References:

1. Desh Raj, 2014. Floriculture at a glance, Kalyani Publishers, New Delhi
2. Kumar, N. 2017. Introduction to horticulture, VIII Edition. Oxford & IBH Publishing co. Pvt. Ltd.
3. Mukherjee. 2008. Speciality Cut Flowers: Production Technologies.- Naya Udyog Publisher.
4. Ponnuswami and Sowmeya. 2015. Flowers and fillers Production technology, Aavishkar Publishers, Jaipur.
5. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
6. Principles of Landscape Gardening – Agrimoon.com

20AG2011 - EDUCATIONAL TOUR – I

Credits 0:0:1 (0+1)

Course Objectives:

To impart knowledge on

1. Functioning of agricultural research institutions throughout the state
2. On-going agricultural research and extension programs
3. Region specific crop production technologies

Course Outcomes:

On completion of this course, students will be able to

1. Categorize agricultural crops grown in the different agro climatic zones of Tamil Nadu.
2. Remember different agro-climatic zones of Tamil Nadu
3. Distinguish social, cultural and economic differences in various agricultural zones.

4. Compare and contrast the different soil types and cropping systems in Tamil Nadu.
5. Recommend climate and region specific cultivation practices.
6. Analyse different rainfall patterns of different agro-climatic zones of Tamil Nadu

Course Content:

The study tour programme is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour programme, full attendance is mandatory for a pass as per the ICAR regulations. The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

20AG2012 - EDUCATIONAL TOUR – II**Credits 0:0:1 (0+1)****Course Objectives:****To impart knowledge on**

1. The various crops and cropping systems of South India.
2. The various agricultural and agro-based institutions/ Research Stations/ Colleges in South India
3. The ongoing agricultural research and extension programmes implemented by the Government and the State Agricultural Universities

Course Outcomes:**On completion of this course, students will be able to**

1. Identify the various crops across the states of South India
2. Discuss the cropping systems practiced in the different agro-climatic zones of South India
3. Describe the soils, irrigation practices, sources of irrigation and other farming related activities in different parts of their visit
4. Assess the scope of farming, agro-based industries and related activities across the states of South India.
5. Relate the social and cultural aspects of the people of different agricultural zones
6. Discuss the commercial operations of farming and related activities

Course Content:

The study tour programme is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour programme, full attendance is mandatory for a pass as per the ICAR regulations. The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

20AG2013 - PRINCIPLES OF SEED TECHNOLOGY**Credits 1:0:2 (1+2)****Course Objectives:****To impart knowledge on**

1. Importance of seed and concepts of seed, its classification, certification, purity and Seed Act.
2. Foundation and certified seed production protocols and procedures of cereals, pulses, oilseeds, fodder and vegetable crops.

3. Seed storage, pest and disease control, seed distribution infrastructure and protocols in India.

Course Outcomes:**On completion of this course, students will be able to**

1. Understand the importance of quality seed in agriculture production.
2. Distinguish types of seeds and know seed certification process.
3. Apply seed production techniques in cereals, pulses, and oilseeds, vegetable and forage seeds.
4. Describe seed structure and morphology, physical characteristics of seed.
5. Conduct varietal identification, seed quality assessments tests and seed treatments.
6. Remember the concepts in seed storage and seed marketing

Theory

Seed and seed technology: introduction, definition, its importance in increasing agricultural production. Difference between seed, grain, and concept of seed quality. Deterioration causes of crop varieties and their control. Maintenance of genetic purity during seed production. Genetic and agronomic principles of seed production. Different classes of seed and truthfully labeled seed. Seed certification, phases of certification. Procedure for seed certification, field inspection. Foundation and certified seed production of important cereals (Rice, wheat and maize), pulses (Cowpea, mung, urd, pigeonpea, field bean and soybean), oilseeds (Sesame, coconut, sunflower, groundnut), fodder (Guinea grass, napier grass and lucern), and vegetables (Bhindi, tomato, brinjal, chillies and cucurbitaceous vegetables). Seed Act and Seed Act enforcement. Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency, Central and State Seed Testing Laboratories. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Seed Bill 2004, and other issues related to seed quality regulation. Varietal identification through electrophoresis and biochemical tests. Synthetic seeds and terminator gene technology. Detection of genetically modified crops. Transgene contamination in non-GM crops, GM crops and organic seed production. Physiological and harvestable maturity. Seed dormancy, internal and external factors affecting dormancy in seeds. Seed drying. Seed processing and their steps. Seed treatment, its importance, methods of application. Seed packing. Seed sampling and testing. Seed storage: general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies. Participatory seed production and seed village concept.

Practical

Varietal identification through seed structure and morphology, physical characteristics of seed and biochemical tests. Germination test in field and horticultural crops. Quick viability test of field and horticultural crops. Seedling vigor tests. Seed sampling principles and procedures; Physical purity analysis of field and horticultural crops. Genetic purity test: Grow out test and electrophoresis. Roguing, field inspection and preparation of field inspection report. Seed production in major cereals, pulses, oilseeds and vegetable crops. Visit to seed testing laboratories, farms and seed processing plants.

References

1. Khare and Bhale. 2014. Seed Technology, Scientific Publishers, New Delhi.
2. Sharma, J.P. 2011. Quality Seed Production of Vegetable Crops Technological Interventions, Volume 2: Crop Specific Aspect. Kalyani Publishers, Ludhiana.
3. Agrawal, P.K. and M. Dadlani. 1995. Techniques in seed science and technology. South Asian Publishers, New Delhi.
4. Agrawal, R.L. 1996. Seed Technology. Oxford & IBH Publication Co., New Delhi.

**20AG2014 - MANURES, FERTILIZERS AND SOIL FERTILITY
MANAGEMENT****Credits 2:0:1 (2+1)****Course Objectives:****To impart knowledge on**

1. The properties and composition of organic manures and chemical fertilizers
2. The mechanism of nutrient transport in plant and soil, plant nutrient deficiency and toxicity symptoms.

3. Soil chemistry, soil fertility testing and plant nutrient analysis

Course Outcomes:**On completion of this course, students will be able to**

1. Understand the properties of manures, fertilizers and soil amendments
2. Summarize the concepts of soil fertility and plant nutrition and chemistry of nutrients in soil.
3. Apply the concept of Integrated Nutrient Management and fertilizer recommendation practices
4. Evaluate the fertility of soil
5. Analyse plant nutrient content
6. Recommend fertilizer dosage for different soil types

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/green leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management. Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, Nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order. Soil fertility concepts and approaches. Soil fertility evaluation – visual, chemical – plant and soil test. Biological methods (Indicator plants and microorganisms) and DRIS. Soil test based fertilizer recommendation, STCR, SSNM. History of soil fertility and plant nutrition. Criteria of essentiality. Role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, and rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions. Applications of advanced techniques in fertiliser recommendation and application – Remote sensing, GIS, GPS, precision agriculture, Big data and cloud computing.

Practical

Methods of fertilizer and manure sampling for analysis. Introduction to analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of soil organic carbon, Estimation of alkaline hydrolysable Nitrogen in soils. Estimation of soil extractable Phosphorus. Estimation of exchangeable potassium, Calcium and Magnesium in soils. Estimation of soil extractable S. Estimation of DTPA extractable Fe, Mn, Cu and Zn in soils. Estimation of Nitrogen, Phosphorus, Potassium and Sulphur in plants.

Reference Books

1. John L. Havlin, L. Samuel Tisdale, L. Werner Nelson and J.D Beaton. 2016. Soil Fertility and Fertilizers 8th Edn.. Pearson Publishers. London.
2. Kolay, A.K. 2007. Manures and Fertilizers. Atlantic Publishers & Distributors (P) Ltd., Chennai.
3. Millar, C. E. 1959. Soil Fertility. John Wiley Publishers, New York
4. Panda, S.C. 2017. Soil Fertility and Nutrient Management. Agrobios (India) Publishers, Jodhpur.
5. Yawalkar, K.S., J.P. Agarwal and S. Bokde. 2002. Manures and Fertilizers (9th Edition). Agri-Horticultural Publishing House, Nagpur- 440010, India.
6. <http://ecoursesonline.iasri.res.in/Courses/ManuresFertilizers&Agrochemicals/SSAC222/>
7. <https://www.pdfdrive.com/principles-and-practice-of-soil-science-the-soil-as-a-natural-resource/>

20AG2015 - FUNDAMENTALS OF PLANT PATHOLOGY**Credits: 3:0:1 (3+1)****Course Objectives****To impart knowledge on**

1. Plant diseases and plant pathogens
2. Classification and life cycle of plant pathogens
3. Basics of plant disease management

Course Outcomes:**On completion of this course, students will be able to**

1. Remember the factors responsible for disease development
2. Understand the importance of different plant pathogens with their characteristics and classification
3. Recall the reproduction, survival and transmission of plant pathogens
4. Outline the mode of dispersal, role of enzymes and toxins in disease development
5. Analyse defense mechanism in plants and the epidemiological factors
6. Apply knowledge on plant disease management

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes / factors affecting disease development: disease triangle, tetrahedron, and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes. Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes. Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction. Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites. Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, Anguina, Radopholus etc.) Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants. Epidemiology: Factors affecting disease development. Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

References

1. Agrios, G. N. 2005. Plant Pathology. 5th Ed..Elsevier Academic Press.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 2014. Introductory Mycology. 4th Ed .Wiley India Pvt td. Jayaraman,
3. Jayaraman, J. and J. P. Verma. 2002. Fundamentals of Plant Bacteriology (Reprint, 2015). Kalyani publishers, New Delhi
4. Ravichandra, N.G. 2013. Fundamentals of Plant Pathology. PHI Learning Pvt Ltd.639p.
5. Walkey, D. G. 1991. Applied Plant Virology (2nd Ed.).Springer.
6. Webster, J. and R.W.S. Weber. 2007. Introduction to Fungi. 3rd Ed. Cambridge University press.
7. Thorne, G. 1971. Principles of Nematology, McGraw Hill Book Co., New York, London

20AG2016 - DISEASES OF FIELD AND HORTICULTURAL CROPS AND THEIR MANAGEMENT – II

Credits: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Major diseases of field and horticultural crops
2. Causal organisms of plant diseases, etiology and disease cycle
3. Integrated farming practices to be followed for effective management of plant pathogens

Course Outcomes:

On completion of this course, students will be able to

1. Recall various plant pathological terms and basic concepts of important plant diseases
2. Explain the disease symptoms of various plant diseases of field and horticultural crops
3. Interpret the host pathogen interaction on disease development in field and horticultural crops
4. Determine the prevalence, epidemiology and factors affecting disease development
5. Apply the concept of integrated management practices to control diseases of field and horticultural crops
6. Recommend management practices for diseases of different crop plants

Theory

Symptoms, etiology, disease cycle and management of following diseases: Field Crops: Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and earcockle; Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng; Sunflower: Sclerotinia stem rot and Alternaria blight; Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot; Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Cotton: anthracnose, vascular wilt and blackarm; Pea: downymildew, powdery mildew and rust.

Horticultural Crops Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis; Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl. Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic; Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch and Stem phylum blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leafspot.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium .Note: Students should submit 50 pressed and well-mounted specimens.

References

1. Arjunan, G. Karthikeyan, G, Dinakaran, D. and T. Raguchander. 1999. Diseases of horticultural Crops, AE Publications, Coimbatore.
2. Das Gupta M.K. and W.C. Mandel.1989. Post-harvest pathogens of Perishables. Oxford and IBH Publishing Company, New Delhi.
3. Rangaswamy, C. 2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi.
4. Dasgupta, M.K. and W.C. Mandal. 1989. Post-harvest pathology of perishables. Oxford IBH publishing Co. New Delhi.
5. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York.
6. Chaube H. S .and Pandhir. 2005.Crop diseases and their management. Prentice hallof IndiaPvt. Ltd. New Delhi
7. Guptha V.K and V.S. Paul. 2004. Fungi and Plant diseases. Kalyani Publishers. New Delhi
8. Mehrota, R.S. 1980. Plant Pathology, Tata Mc Graw Mill Pub. Co., NewDelhi,
9. Prakasam, V., V. Valluvaparidasan, T. Raguchander, and K.Prabakar. 1997. Field crop diseases, AE Publication, Coimbatore.
10. Singh, R.S .1993. Plant Diseases, Oxford &IBH Publication, New Delhi.
11. Agrios, G.N. 2008. Plant Pathology, Academic Press,NewYork
12. Rangasawmi, G and A. Mahadevan, 1998. Diseases of crop Plants in India, Prentice Hall of

India Pvt. Ltd., New Delhi

20AG2017 - POST HARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of postharvest processing of fruits and vegetables
2. Different preservation techniques and value addition process of important fruits and vegetables
3. Government schemes and laws regulating import and export of fresh fruits and vegetables

Course Outcomes:

On completion of this course, students will be able to

1. Remember the different post-harvest management of important fruits and vegetables
2. Understand the factors causing post-harvest losses in fruits and Vegetables
3. Explain about the different value addition process of important fruits and vegetables
4. Analyse the market, demand and supply chain for important fruits and vegetables
5. Recommend suitable storage structures and packaging methods for postharvest management of fruits and vegetables
6. Demonstrate knowledge about the different government schemes and laws in import and export of fruits and vegetables

Theory

Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post-harvest losses. Importance and scope of fruit and vegetable preservation industry in India, food pipeline, losses in post-harvest operations, unit operations in food processing. Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning concepts and standards, packaging of products. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Applications of different types of packaging, containers for shelf life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Quality evaluation of products -- physico-chemical and sensory. Visit to processing unit/ industry. Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

References:

1. Verma, L. R. and V. K. Joshi. 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.
2. FAO - Training Manual No.17/2. 2007. Prevention of post-harvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.
3. Morris, T. N. 2006. Principles of Fruit Preservation. Biotech Books, Delhi. 81-7622-116-3.
4. Rathore N.S., G.K. Mathur and S.S. Chasta 2012. Post-Harvest Management and Processing

- of Fruits and Vegetables. The Energy And Resources Institute
5. Srivastava, R. P. and S. Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.

20AG2018 - ENVIRONMENTAL SCIENCES AND DISASTER MANAGEMENT

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The natural resources- Renewable and Non renewable
2. The Ecosystem, Biodiversity , Environmental pollution and conservation aspects
3. The Natural and Man- made Disasters and their Management

Course Outcomes:

On completion of this course, students will be able to

1. Identify and distinguish the natural resources- Renewable and Non -renewable.
2. Illustrate the concepts of ecosystem and biodiversity.
3. Examine and solve environmental pollution issues.
4. Plan the conservation strategies.
5. Perform environmental auditing and assessing environmental impact
6. Make use of Environmental modeling

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer- pesticide problems, waterlogging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem:

- a) Forest ecosystem
- b) Grassland ecosystem.
- c) Desert ecosystem
- d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
- e) Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India.
- f) Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
- g) Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution: definition, cause, effects and control measures

- a) Air pollution
- b) Water pollution
- c) Soil pollution
- d) Marine pollution
- e) Noise pollution
- f) Thermal pollution

g) Nuclear hazards.

Solid Waste Management: causes, effects and control measures of urban and industrial wastes.

Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management

Natural Disasters Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Expected impact of climate change on agricultural production and water resources, Mitigation Strategies, Economics of climate change. Disaster Management introduction, Natural and Manmade Disaster Studies, Informatics for Disaster Management, Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.

Suggested Readings

1. Bharucha Erach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants Commission, University Press, Hyderabad.
2. Sharma J P. 2003. Introduction to Environment Science. Lakshmi Publications.
3. Manohar, C. and J. R. Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad.
4. Kaul S. N. and A. Gautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.
5. Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air. Agro bios, Jodhpur.
6. Climate change. 1995: Adaptation and mitigation of climate change-Scientific Technical Analysis Cambridge University Press, Cambridge.
7. Sharma, R.K. and G. Sharma. 2005. Natural Disaster. APH Publishing Corporation, New Delhi.
8. Majid, H. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. online book.

22HO1001- PLANT PROPAGATION AND NURSERY MANAGEMENT

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Principles and tools involved in propagation of horticultural crops

2. The propagation structures and plant materials used in the multiplication of horticultural crops
3. Scope and techniques of micro-propagation in horticultural crops

Course Outcomes:**On completion of this course, students will be able to**

1. Demonstrate propagation and nursery management techniques for horticultural crops
2. Describe various structures used for propagation
3. Select mother plant and prepare the propagation plant materials
4. Handle tools used in propagation and achieve skill oriented knowledge
5. Manage nursery, maintain records, prepare young plants for propagation
6. Outline the micro-propagation techniques for horticultural crops

Theory

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification & stratification) internal and external factors, nursery techniques nursery management, apomixes – monoembryony, polyembryony, chimera and bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements) and use of growth regulators in seed, types and stages of seed germination with examples. Vegetative propagation, methods and techniques of division- stolons, pseudo-bulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding physiological and bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility.

Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micro-propagation – Micro-grafting, meristem culture, callus culture, anther culture, organogenesis, soma clonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery. Cost of establishment of propagation structures.

Practical

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, grafting and budding including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery. Cost of establishment of propagation structures.

Suggested Reading:

1. Hartmann, H.T., D.E. Kester, F.T. Davies and R.L. Greeneve. 2006 Plant Propagation. Principles and Practices. Prentice Hall of India Private Ltd., New Delhi.
2. Prasad, S. and U. Kumar, 2005. Principle of Horticulture. 3rd edition, Agrobios, India.
3. Guy W. Adriance and Feed R. Brison. Propagation of Horticultural Plants. Axis Books (India).
4. S. Rajan and B. L. Markose (series editor Prof. K.V. Peter). Propagation of Horticultural Crops- Horticulture Science Series vol.6. New India Publishing Agency, Pitam Pura, NewDelhi-110088.
5. Sadhu, M.K. 1996. Plant Propagation. New age International Publishers, New Delhi.
6. Mukherjee, S. K. and P. K. Majumdar. 1973. Propagation of fruit crops. ICAR, New Delhi.
7. Ganner, R.J. and S.A Choudhri. 1972. Propagation of Tropical fruit trees. Oxford and IBN publishing Co., New Delhi.
8. Sarma, R.R. 2002. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
9. Symmonds, 1996. Banana. II edition Longman, London.

20HO1002 - WEED MANAGEMENT IN HORTICULTURAL CROPS

(18HO1006 Irrigation and Weed Management in Horticultural Crops)

Credit: 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. Identification of weeds, characters of weeds, and classification of weeds
2. Methods of weed control and Integrated weed management in different crops/ cropping systems
3. Herbicide classification, formulation, application, selectivity and compatibility of herbicides

Course outcomes:

On completion of this course, students will be able to

1. Identify different types of weeds and their ecosystem
2. Understand the weeds survival mechanisms
3. Recommend herbicides understanding their effects on the crops
4. Adopt different weed control methods
5. Apply integrated weed management practices
6. Analyse the economics of weed control in horticultural crops

Theory

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses. Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Suggested Reading:

1. Crafts, A.S. and W.W. Robbins. 1973. Weed Control. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Gupta, O.P. 1984. Scientific Weed Management. Today and Tomorrow Printers and Publishers, New Delhi.
3. Gupta, O.P. 2015. Modern Weed Management. Agro Bios (India), Jodhpur.
4. Naidu, V.S.G.R., Handbook of Weed Identification. Directorate of Weed Research, Jabalpur.
5. Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. Weed management of Horticultural Crops. Agrobios (India), Jodhpur.
6. Ramamoorthy, K. and Subbian, P., Predominant Weed flora in hill –ecosystems. Agrobios (India), Jodhpur.
7. Rao, V.S. 2000. Principles of Weed Science. Oxford & IBH Publishing Co., New Delhi.
8. Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. All About Weed Control. Kalyani Publishers, Ludhiana.
9. Tadulingam, C. and Venkatnarayana, D. 1955. A Handbook of Some South Indian Weeds. Government Press, Madras.
10. Thakur, C. 1977. Weed Science. Metropolitan Book Co. Pvt. Ltd., New Delhi.

20HO1003 - FUNDAMENTALS OF FOOD TECHNOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Basic concepts of food and its function
2. Food preparation techniques
3. Effect of micronutrients on health

Course Outcomes:

On completion of this course, students will be able to

1. Identify the composition and the nutritive value of different food.
2. Understand differences between well and malnourished populations.
3. Analyse the energy requirement of human system.
4. Apply the knowledge to design food based on the needs of the population.
5. Evaluate the effect of cooking on food preparations
6. Plan and prepare diets for various age groups

Theory

Food and its function, physico-chemical properties of foods, food preparation techniques, nutrition, relation of nutrition of good health. Characteristics of well and malnourished population. Energy, definition, determination of energy requirements, food energy, and total energy needs of the body. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

Practical

Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy, value proteins and fat content in food. Planning diet for various age groups.

Suggested Reading:

1. Swaminathan, M. 1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
2. Swaminathan, M. 1985. Essential of Food and Nutrition Vol. II. BAPPCO, Bangalore.
3. Manoranjan, K. and S. Sangita. 1996. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
4. Srilakshmi. 2010. Food Science. New age International 978-81-224-2724-0.
5. Srilakshmi. 2005. Dietetics. New age International 978-81-224-1611-4.
6. Shankunthala, M. 1972. Foods-Facts, Principles & Procedure. The Eastern Press, Bengaluru.
7. Passmore, R. and M. A. Eastwood. 1986. Human Nutrition & Dietetics. ELBS 0443039194.
8. Anita, T. 1996. Food and Nutrition. Oxford 0198327668.
9. Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science, technology, and Quality Management. Kalyani Publishers 81-272-
10. Monoranjan, K. and S. Sangita. 2008. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
11. George, I. S. and D. L. Dennis. 1994. Chemistry for the Health Science. MacMillan 0-02-405161-6.
12. Masferton and Hurley. 1989. Chemistry Principles and Reactions. Saunders Golden Sunburst 0-03-005889-9.
13. Bettelheim and March. 1984. Introduction to General, Organic & Biochemistry. Harcourt Brace college Puplichers 0030202175 Sounders College Pupliching.
14. Gopalan, G., B.V. Ramasastri, and S. C. Balasubramnian. 1989. Nutritive valve of the Indian Foods. National Institute of Nutrition, ICMR, Hyderabad. <http://www.fao.org/infoods/>
15. Swaminathan, M. 1988. Hand book of Food Science & Experimental Foods. Bappco publishers, Bangalore
16. Manay, S.N. and M. Shadaksharaswamy. 1998. Food-facts & Principles New Age International Publishers, New Delhi

17. Srilakshmi, B. 1995. Food Science. New Age International Publishers, New Delhi.

20HO1004 - PRINCIPLES OF LANDSCAPE ARCHITECTURE

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Historical importance of gardens and various styles of gardens in India and other countries
2. Principles and elements of landscape gardens
3. Planning and designing of different landscape

Course Outcomes:

On completion of this course, students will be able to

1. Understand the historical importance of gardens in India
2. Describe the essential features of various styles of gardens
3. Apply Auto CAD and Arch CAD for the designing of garden components
4. Plan and implement the garden design for different types of landscape
5. Implement garden principles suitable for varied landscape
6. Understand and implement bio aesthetic plan for different geographical locations

Theory

Historical Importance of Indian gardens, gardens of ancient world, definitions, famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, steps in preparation of garden design. Use of Auto CAD and Arch CAD in designing gardens. Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc.. Elements of landscape gardens viz. tangible and intangible elements. Bio-aesthetic planning, definition, objectives. Planning and designing of home gardens, colonies, country planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydroelectric stations, river banks, play grounds, Gardens for places of religious importance viz. temples, churches, mosques, tombs etc. Importance, features and establishment of English garden, Japanese gardens, Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens, xeriscaping, definition, principles and practice.

Practical

Study of garden equipment. Study of graphic language, use of drawing equipment, graphic symbols and notations in landscaping designing, study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using Auto-CAD/ Archi-CAD, designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, temples, churches, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and national highways. Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

Suggested Reading:

1. Tiwari, A. K. and R. Kumar. 2012. Fundamentals of ornamental horticulture and landscape gardening. New India.
2. Grewal, H.S. and P. Singh. 2014. Landscape designing and ornamental plants
3. R.K. Roy. 2013. Fundamentals of Garden designing. New India publishing agency, Pitampura, New Delhi.
4. Srivastava, R. 2014. Fundamentals of Garden designing. Agrotech press, Jaipur, New Delhi.
5. De, L.C. 2013. Nursery and landscaping. Pointer publishers, Jaipur India.
6. Bose, T.K. R.G. Malti, R.S. Dhua, and P. Das. 2004. Nayaprakash, Calcutta. Floriculture and Landscaping
7. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana.
8. Randhawa, G.S. and A. Mukhopadhyay 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi

20HO1005 - FUNDAMENTALS OF SOIL SCIENCE

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Soil forming process and physical properties of soil.
2. Soil chemical properties and reactions.
3. The impacts of soil pollution and the remediation measures.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genesis, pedological and edaphological concepts of soil
2. Remember different systems of soil classification
3. Evaluate the soil chemical properties and use them for soil reclamation.
4. Describe the physical properties of soil
5. Apply the knowledge for choosing crops and irrigation systems
6. Analyse the soil pollutant factors and recommend suitable remedial measures for soil improvement

Theory

Composition of earth's crust, soil as a natural body – major components. Soil forming process involved in formation of various soils. Physical parameters; texture – definition, methods of textural analysis, Stokes' law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), PD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value, hue, chroma and Munsell colour chart. Factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal. Soil temperature, sources and distribution of heat, factors influencing, measurement. Chemical properties; soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Rock & Minerals classification, Pedogenic process. Objectives of soil science research institute in India (NBSS & LUP, ISSS, LTFE & NSSTL). Management of soil crusting, soil compaction and soil compression. Soil biology benefits and harmful effects. Methods and objective of soil survey Remote sensing application in soil and plant Studies, Soil degradation. Elementary knowledge of soil taxonomy classification and soils of India. Soil organic matter: composition, properties and its influence on soil properties; humic substances. Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution

Practical

Collection and preparation of soil samples, estimation of soil Ph, EC and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Identification of minerals and their abundance. Determination of soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of infiltration rate using double ring infiltrometer method. Estimation of soil moisture using gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of pore space of soil. Determination of field capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by field method. Determination of cation exchange capacity of Soil. Study of soil map. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

20HO1006 - WATER MANAGEMENT IN HORTICULTURAL CROPS

Credit: 1:0:1 (1+1)

Course objectives

To impart knowledge on

1. Soil, water and plant relationships and soil moisture constant with special reference to horticultural plants
2. Working principles of water measuring devices and water management tools
3. The impact of water on horticultural crop production and its management

Course outcomes:

On completion of this course, students will be able to

1. Understand the role of water in metabolic and physiological functions of plants
2. Understand the water requirement of horticultural crops
3. Scheduling irrigation for horticultural crops based on scientific knowledge gained
4. Apply the irrigation management structures for efficient water use
5. Analyse the different water management problems
6. Outline the layout of different irrigation systems

Theory

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

Practical

Measurements of irrigation water by using water-measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices.

Suggested Reading:

1. Rao, Y.P. and S.R. Bhaskar. 2008. Irrigation Technology. Theory and practice. Agrotech publishing Academy, Udaipur.
2. Dilip Kumar Mujmdar. 2004. Irrigation Water Management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
3. S.V. Patil and G.R. Rajakumar. 2016. Water Management in Agriculture and Horticultural Crops. Satish serial publishing House, New Delhi.
4. Carr M. K. V. and Elias Fereres. 2012. Advances in Irrigation Agronomy. Cambridge University Press.
5. Michael, A.M. 2015. Irrigation Theory and Practices. Vikas publishing house Pvt., Ltd.

20HO1007 - AGRO-METEOROLOGY AND CLIMATE CHANGE

Credit: 1:0:1 (1+1)

Course Objectives

To impart knowledge on

1. Agricultural meteorology and its role in crop production
2. Atmospheric weather variables, climatic factors and their measurements
3. Climate change and its effect on crop production

Course Outcomes

On completion of this course, students will be able to

1. Understand the significance of agricultural meteorology, climate and weather
2. Explain the various atmospheric weather variables and its significance in crop production
3. Discuss crop weather relationships for efficient crop production
4. Acquire knowledge on weather forecasting techniques and effect of climate change on crop production
5. Describe artificial rainmaking, precipitation, monsoons and its importance in Indian Agriculture
6. Discuss global warming, and its effect on regional and national agriculture

Theory

Agricultural meteorology- Introduction, definition of meteorology, scope and practical utility of agricultural meteorology. Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought, weather disasters and their management atmospheric pollution and role of meteorology. Basics of weather forecasting and climate change-causes. Global warming-causes and remote sensing. Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases. Atmospheric chemistry. Plants sense and respond to changes in CO₂ concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C3 and C4 species. Plant development affected by growth in elevated CO₂. Physiology of rising CO₂ on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO₂. Change in secondary metabolites and pest disease reaction of plants. The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

Practical

Site selection for agro met observatory; measurement of temperature; measurement of rainfall; measurement of evaporation (atmospheric/soil); measurement of atmospheric pressure; measurement of sunshine duration and solar radiation; measurement of wind direction and speed and relative humidity; study of weather forecasting and synoptic charts. visit to meteorological observatory, visit to IMD meteorological observatory-lay out plan of standard meteorological observatory. Recording of air and soil temperature. Measurement of radiation and components, Measurement of rainfall-different types of rain gauges, Measurement of wind speed and direction and atmospheric humidity, recording of evaporation. Synoptic charts and weather reports, symbols, *etc.*

Suggested Reading:

1. Srivastava K. and P. K. Tyagi, 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
2. Lenka, D. 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
3. Prasad Rao, G. S. L. H. V., 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Mavi H.S. and Graeme J. Tupper, 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
5. Mavi, H.S. 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Nanjappa, H.V. and B. K. Ramachandrappa, 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
7. Reddy, S. R. 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.
8. Yellamanda Reddy, T. and G. H. Sankara Reddi, 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.

9. Pattersen, S.1958. Introduction to Meteorology. Mc. Graw Hill Book Co. Inc., New York
10. Tailor, J.T.1967. Agricultural Climatology. Pergman Press Ltd., Headington Hill Hall, Oxford, England
11. Trewarthe, T.G.1968. An Introduction to Climate. Mc Graw Hill BookCo. Inc., New York.
12. Mavi, H.S.1985. Introduction to Agrometeorology. Oxford & IBH Publishing Co., New Delhi.

20HO1008 ECONOMICS AND MARKETING

Credits: 2:0:1 (2+1)

Course objectives:

To impart knowledge on

1. Concepts of agricultural market structure and its classification
2. Theories of demand and supply of agricultural produce in market-oriented economy
3. Marketing of agricultural produce and preparation of individual projects

Course Outcomes:

On completion of this course, students will be able to

1. Understand the consumption, demand and supply in agricultural economics
2. Recall the concepts of agricultural marketing
3. Identify the factors affecting the agricultural production
4. Understand the marketing margin and marketing functions
5. Apply the knowledge on market intelligence, SWOT analysis and financial crisis management
6. Prepare project proposals and project reports using techno – economic parameters

Theory

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engel's law of family expenditure – consumer's surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization. Merits and demerits. Laws of return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures. Gross Domestic Product (GDP) – Role of horticultural sector in national GDP. Marketing- definition, marketing process, need for marketing, role of marketing, marketing functions, classification of markets, marketing channels, price spread, marketing efficiency, integration, constraints in marketing of agricultural produce, market intelligence, bank norms, insurance, SWOT analysis, crisis management. Techno-economic parameters for preparation of projects and basic guidelines for preparation of project report.

Practical

Techno-economic parameters for preparation of project. Preparation of bankable projects for various agricultural products and its value-added products. Identification of marketing channel, calculation of price spread identification of market structure and visit to different markets.

References

1. Philip, K. 2004. Marketing Management. Prentice Hall, New Delhi.
2. Philip, K. 2004. Principles of Marketing. Prentice Hall, New Delhi.
3. Dewett, K.K. 2005. Modern Economic Theory. S. Chand, New Delhi.
4. Dewett, K.K., Verma. 2004 Elementary Economic Theory. S.Chand, New Delhi
5. Jhingan, M.L.2001. Micro Economic Theory. Konark publishers, New Delhi
6. Subba Reddy. S. Raghu Ram. P. NeelaKanta Sastry. T.V. Bhavani Devi. I. 2008. Agricultural Economics (2ndEdn.). Oxford and IBH publishing Co Pvt Ltd, New Delhi
7. Acharya. S.S. 2019. Agricultural Marketing in India (7thEdn.). 2019. Oxford and IBH

publishing Co Pvt Ltd, New Delhi

20HO1009 - ELEMENTARY PLANT BIOCHEMISTRY

Credit: 1:0 (1+1)

Course Objectives:

To impart knowledge on

1. Role of biochemistry in medicine, agriculture and pharmaceutical industries
2. Importance of biomolecules with structure classification and function
3. Synthesis and storage of metabolic energy

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of biomolecules in medicine, agriculture, pharmaceuticals and ethics
2. Identify, classify and group the biomolecules and
3. Draw the structure and comprehend the properties of biomolecules
4. Understand the basic mechanism of various biosynthetic pathways
5. Conceptualize the integration of various metabolic processes and their importance
6. Explain the structures of carbohydrates, proteins, vitamins, nucleic acids and lipids in drug discovery

Theory

Carbohydrates: occurrence, classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation. Lipids: classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance. Plant pigments – structure and function of chlorophyll and carotenoids, sterols, basic structure, role of brassino sterols in plants. Proteins: classification, function and solubility, amino acids –classification and structure, essential amino acids, properties of amino acids, colour reactions, amphoteric nature and isomerism; structure of proteins – primary, secondary tertiary and quaternary properties and reaction of proteins. Enzymes: classification and mechanism of action; factors affecting enzyme action, co-factors and coenzymes. Vitamins and minerals as co-enzymes/ co-factors. Carbohydrate metabolism – glycolysis and TCA-cycle; metabolism of lipids, fatty acid oxidation, biosynthesis of fatty acids, electron transport chain, bioenergetics of glucose and fatty acids, structure and function of nucleic acid replication, transcription and translation.

Practical

Preparation of standard solutions and reagents; Carbohydrates: Qualitative reactions. Estimation of starch; Estimation of reducing and non-reducing sugars from fruits. Amino acids: Reactions of amino acids. Proteins: Estimation of proteins by Lowry's method; Fatty acids: Estimation of free fatty acids; Determination of iodine number of vegetable oils; Vitamins: Estimation of Ascorbic acid; Techniques: Paper chromatography, Thin layer chromatography; Electrophoresis of pigments extracted from flowers, Extraction of oil from oil seeds; Enzymes: Enzyme assay, Enzyme Immobilization.

Suggested Reading:

1. Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry*. Freeman Publishers
2. Voet, D and J. G. Voet. 2004. *Biochemistry* 4th Edn. Wiley & sons Publishers. USA.
3. Sadashivam, S and A Manickam,. 1996. *Biochemical methods for Agricultural sciences*. New age International publishers, New Delhi.
4. Voet, D. and J.G Voet. 2004. (3rd edit). *Biochemistry*. John Wiley & sons Incl.USA.
5. Rameshwar, A. 2006. (3rd edit). *Practical Biochemistry*. Kalyani Publishers, NewDelhi.
6. Buchanan, B. B., W. Gruissem, and R. L. Jones, 2002. *Biochemistry and molecular biology of plants*. 2nd edition. Blackwell publications, UK.

20HO1010 - ELEMENTARY PLANT BIOTECHNOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The basic Concepts of Biotechnology
2. Micro propagation and genetic engineering techniques in plants
3. Nanotechnology and its application in plants

Course Outcomes:

On completion of this course, students will be able to

1. Understand the structure and function of prokaryotic and eukaryotic cells.
2. Conceptualize the mechanism gene replication, transcription, translation
3. Apply micro propagation techniques to propagate plants
4. Understand the various genetic engineering tools for plant improvement
5. Detect the transgenic using immunological techniques and markers.
6. Comprehend the importance of nanoparticles and its use in agriculture

Theory

Concepts of plant biotechnology: history of plant tissue culture and plant genetic engineering. Scope and importance in crop improvement: totipotency and morphogenesis, nutritional requirements of in-vitro cultures. Techniques of in-vitro cultures, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, test tube fertilization, endosperm culture, factors affecting above in-vitro culture; applications and achievements; somaclonal variation, types, reasons: somatic embryogenesis and synthetic seed production technology; protoplast isolation, culture, manipulation and fusion; products of somatic hybrids and cybrids, applications in crop improvement. Genetic engineering; restriction enzymes; vectors for gene transfer – gene cloning – direct and indirect method of gene transfer – transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples, Nano toxicology and safety.

Practical

Requirements for plant tissue culture laboratory; techniques in plant tissue culture. Media components and preparations; sterilization techniques and inoculation of various explants; aseptic manipulation of various explants; callus induction and plant regeneration; micro propagation of important crops; anther, embryo and endosperm culture; hardening / acclimatization of regenerated plants; somatic embryogenesis and synthetic seed production; isolation of protoplast; demonstration of culturing of protoplast; Demonstration of isolation of DNA; demonstration of gene transfer techniques, direct methods; demonstration of gene transfer techniques, indirect methods; demonstration of confirmation of genetic transformation; demonstration of gel electrophoresis techniques. Green synthesis of Nano particles and their size characterization.

Suggested Reading:

1. Singh, B D, 2004. Biotechnology Expanding Horizons 2nd Edn. Kalyani Publishers, New Delhi.
2. Gupta, P.K., 2015. Elements of Biotechnology 2nd Edn. Rastogi and Co., Meerut.
3. Razdan M K, 2014. Introduction to plant Tissue Culture 2nd Edn. Science Publishers, inc. USA.
4. Gautam V K, 2005. Agricultural Biotechnology. Sublime Publications
5. Thomar, R.S., M.V., Parakhia, S.V Patel,. and B.A Golakia. 2010. Molecular markers and Plant Biotechnology, New Publishers, New Delhi.
6. Purohit, S.S., 2004. A Laboratory Manual of Plant Biotechnology 2nd Edn. Agribios, India.
7. Singh, B.D. 2012. Plant Biotechnology. Kalyani publishers, Ludhiana
8. Bilgrami, K.S. and Pandey, A.K.1992. Introduction to Biotechnology. CBS Pub. New Delhi
9. Gupta, P.K. 1994. Elements of Biotechnology. Rastogi Pub. Meerut.
10. Chahal, G.S. and Gosal, S.S.2003. Principles and Procedures of Plant Approaches Breeding Biotechnological and Conventional. Narosa Publishing House, New Delhi

20HO1011 - INTRODUCTORY CROP PHYSIOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Concept of water relations in plants
2. Physiological processes of plant and its effects on plant growth
3. Role of plant growth regulator and its application in crop growth

Course Outcomes:

On completion of this course, students will be able to

1. Understand the physiology of plant tissues and cells
2. Remember water movement in plant systems like diffusion and osmosis
3. Apply the concept of water relations, mineral uptake in the field of agriculture
4. Summarize the various physiological processes
5. Measure and analyse the physiological parameters of crops
6. Practice the use of growth regulators correctly to solve physiological problems

Theory

Water relations in plants: role of water in plant metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant nutrition: essentiality, mechanism of absorption and its role in plant metabolism. Biological nitrogen fixation photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO₂ fixation – C₃, C₄ and C₄ metabolism, advantages of C₄ pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, secondary metabolites and plant defense.

Practical

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

Suggested Reading:

1. Salisbury. 2007. *Plant Physiology*. CBS. New Delhi.
2. Taiz, L. 2010. *Plant Physiology*. SINAUR. USA.
3. Zeiger. 2003. *Plant Physiology*. PANIMA. New Delhi.
4. Edward E. Durna. 2014. *Principles of Horticultural Physiology*. CABI, UK.
5. Delvin, R.M. 1986. *Plant Physiology*. CBS. Delhi.
6. Richard, N. Arteca. 2004. *Plant Growth Substances*. CBS. New Delhi.
7. Jacobs, W. P. 1979. *Plant Hormones and Plant Development*. Cambridge Univ. London.
8. Basra, A. S. 2004. *Plant Growth Regulators in Agriculture & Horticulture*. HAWARTH press. New York.
9. Lincoln Taiz and Eduards Zeiger (5th Edition). *Plant physiology*
10. Noggle G.R and Fritz T.G. *Introductory Plant Physiology*
11. Pandey and Sinha. *Plant Physiology*
12. Salisbury and Ross. *Plant Physiology* fifth Deans' Committee
13. Carl fedtke. *Biochemistry and Physiology of Herbicide Action*
14. Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. *Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation* Horst Marschner, *Mineral Nutrition of Higher plants*

20HO1012- INTRODUCTORY MICROBIOLOGY

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The discovery of microbial cells, their structure and metabolism
2. The different types of microscopes and staining techniques.
3. The beneficial use of microorganisms and their genetics

Course Outcomes:

On completion of this course, students will be able to

1. Acquire knowledge about the structure of microbes
2. Understand the genetics and metabolism in bacterial cells
3. Evaluate the different sterilization methods
4. Apply the concepts of beneficial microbes in industries
5. Explain the types of interaction between different soil microflora
6. Isolate different agricultural important microbes using different culture media

Theory

History and scope of microbiology: the discovery of microorganism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and specimen preparation: the bright field microscope, fixation, dyes and simple staining, differential staining. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelia growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association. Sterilization methods – physical and chemical, isolation of pure cultures and preservation of cultures, plant growth promoting microorganisms and mushrooms – economic importance, industrially important microorganisms in large-scale production and common microbial fermentations. Mushrooms- edible and poisonous types, nutritive values, culturing and production techniques.

Practical

Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plates, turbid metric estimation of microbial growth, mushroom culture- spawn production, culture and production techniques, harvesting, packing and storage.

Reference Books

1. Madigan, M.T. and J. M Martinko, 2014. Brock Biology of Microorganisms 14th Edn. Pearson.
2. Heritage, J., E G V Evans, R A Killington, 2008. Introductory Microbiology. Cambridge University press P. date
3. Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. Biology of Microorganisms. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Singh, R.P. 2007. General Microbiology. Kalyani Publishers.
5. Pelczar, M. J. 1998. Microbiology 5th Edn. Tata Mc. Grow Hill Education Pvt. Lt

20HO1013-FUNDAMENTALS OF EXTENSION EDUCATION

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. The concept of extension education and its importance in agriculture development
2. Various rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis
3. The new innovations being brought into the agricultural extension in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand agricultural extension and rural development programs
2. Create employment opportunity based on the knowledge gained on different schemes operated

- by state and central governments.
3. Remember the new innovations in the area of agricultural extension in India
 4. Apply the practical knowledge gained on technology transfer from lab to land.
 5. Create awareness among farmers on different communication technology and journals available for scientific farming
 6. Apply the knowledge for uplifting poor and marginal farmers

Theory

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Horticulture extension: process, principles and selected programmes of leading national and international horticultural institutes. People's participation in horticulture programmes. Motivation of farmers, rural youth and voluntary organizations for horticulture extension work rural development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) krishi vigyan kendras (KVK), technology assessment and refinement programme (TARP) etc. of ICAR. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Adoption and diffusion process, teaching and learning-concepts and principles, teaching steps, programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of participatory rural appraisal (PRA) & rapid rural appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. ICT in extension education, ICT use in rural India.

Practical

Visits to study structure, functions, linkages and extension programmes of ICAR institutes/ voluntary organizations/ Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPV like poster, chart, flash cards, folders etc. and Audio Visual Aids like OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of horticultural extension programmes. Preparation of Village horticultural productions plan.

Suggested Reading:

1. Adivi Reddy, A., 2001, Extension Education, Sree Lakshmi press, Bapatla.
2. Dahama, O. P. and Bhatnagar, O.P., 1998, Education and Communication for Development, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
3. Jalihal, K. A. and Veerabhadraiah, V., 2007, Fundamentals of Extension Education and Management in Extension, Concept publishing company, New Delhi.
4. Muthaiah Manoraharan, P. and Arunachalam, R., Agricultural Extension, Himalaya Publishing House (Mumbai).
5. Sagar Mondal and Ray, G. L., Text Book on Rural Development, Entrepreneurship and Communication Skills, Kalyani Publications, Bangalore.
6. Rathore, O. S. et al., 2012, Handbook of Extension Education, Agrotech Publishing Academy, Udaipur.
7. Ray, G. L., 1991 (1st Edition), Extension Communication and Management, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
8. Supe, S. V., 2013 (2nd Edition), A Text Book of Extension Education, Agrotech Publishing Academy, Udaipur.
9. Van Den Ban, A. W. and Hawkins, H. S., Agricultural Extension, S. K .Jain for CBS Publishers & Distributors, New Delhi.

20HO2001- TROPICAL AND SUBTROPICAL FRUITS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. The scope and production details of tropical and subtropical fruits crops fruit crops in India
2. The physiology, characteristics and production techniques of these fruit crops.

3. The post-harvest management techniques involved in the preservation and processing of tropical and subtropical fruits crops

Course Outcomes:**On completion of this course, students will be able to**

1. Explain the biology and classification of tropical and subtropical fruits crops
2. Identify the various tropical and subtropical fruit crops
3. Describe the specific production technology and cultural practices for each of these fruit crops
4. Identify the physiological disorders associated with these crops and their control measures
5. Explain production constraints
6. Demonstrate harvesting and post-harvest handling of tropical and subtropical fruits

Theory

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops namely Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and causal factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Practical

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

Reference books

1. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series, Vol-8. Ed. by K.V. Peter, New India Publishing Agency, New Delhi.
2. Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. Tropical and Sub-Tropical-Vol-I. Nayayudyog Kolkata
3. Chadha, K. L. (ICAR) 2002, 2001. Hand book of Horticulture. ICAR, New Delhi.
4. Chattopadhyay, T. K. 1997. Textbook on pomology. Kalyani Publishers, New Delhi.
5. Chundawat, B.S., 1990. Arid fruit culture. Oxford and IBH, New Delhi.
6. Dhillon, W. S. 2013. Fruit Production in India. Narendra Publishing House, New Delhi
7. Ladaniya, M. S. 2013. Citrus Fruits. Elsevier, India post ltd.
8. Radha T and Mathew L., 2007. Fruit crops. New India Publishing Agency.

20HO2002- ORCHARD AND ESTATE MANAGEMENT**Credit: 1:0:1 (1+1)****Course objectives:****To impart knowledge on**

1. Importance and objectives of orchard and estate management
2. Different cropping systems and their management in orchards and estates
3. Rejuvenation of old orchards through different methods

Course outcome:**On completion of this course, students will be able to**

1. Outline the basic designs of orchards and estates
2. Remember the different cropping systems in orchards and estates
3. Manage irrigation weed and nutrient applications in orchards and estates
4. Understand the importance of intercultural operations in orchards and estates
5. Identify cultivation constraints in the orchards and offer solutions
6. Rejuvenate old orchards using traditional and modern methods

Theory

Orchard & estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of horticultural crops.

Practical

Layout of different systems of orchard and estate. Soil management. Clean, inter, cover, mixed cropping and fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

Suggested Reading:

1. Kumar, 1990. Introduction to Horticulture crops. Rajyalakshmi Publications, Nagercoil, Tamil Nadu.
2. Palaniappan, S.P. and Sivaraman, K. 1996. Cropping systems in the Tropics. New age International (P) Ltd., Publishers, New Delhi.
3. Shanmugavelu, K.G.1989. Production Technology of Fruit Crops. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Dhillon, W. S. and Bhatt. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi.
5. Mazumdar, B. C. 2004. Principles and Methods of Orchard Establishment. Daya Publishing House, New Delhi.
6. Pradeep Kumar, T., Suma, B., Jyothi Bhaskar and K.N.Satheson. 2008. Management of Horticultural Crops. New India Publishing Agency, New Delhi.
7. Mazumdar, B.C. 2004. Orchard Irrigation and Soil Management Practices Daya Publishing Agency, New Delhi. Daya Publishing Agency, New Delhi

20HO2003- PLANTATION CROPS**Credit: 2:0:1 (2+1)****Course Objectives:****To impart knowledge on**

1. Scope and importance of plantation crops
2. The basics and advances in the production technology of plantation crops.
3. The role of various government organizations and industry involvement in production and processing of plantation crops

Course Outcomes**On completion of this course, students will be able to**

1. Prepare layout and mother plant selection of plantation crops
2. Describe the propagation methods of plantation crops
3. Understand various cultivation practices in plantation crops
4. Examine the physiological disorders and recommend remedial measures
5. Know the harvesting, postharvest handling and processing techniques of plantation crops
6. Estimate market potential and economics of plantation crop cultivation

Theory

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micropropagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

Practical

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

Suggested Reading:

1. Kumar, N. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.
2. Thampan, P.K. 1981. *Hand Book of Coconut Palm*. Oxford IBH, New Delhi.
3. Nair 1979. *Cashew*. CPCRI, Kerala
4. Wood, GAR, Lass R.A. 2001. Fourth edition reprinted. *Cocoa*. Wiley-Blackwell. London
5. Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.
6. Thompson, P.K. 1980. *Coconut*. Oxford & IBH Publishing Co. Ltd., New Delhi.

20HO2004 TEMPERATE FRUIT CROPS

Credits 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of cultivation and production of temperate fruit crops
2. Nutrient, weed and irrigation management of temperate fruit crops
3. Production constraints and management aspects of temperate fruit crop cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Identify the various kinds of temperate fruit crops
2. Remember commercial varieties and propagation methods of temperate fruits
3. Describe the cultivation aspects and cropping systems of temperate fruit crops
4. Elucidate the importance of high density planting, nutrient, weed and irrigation management of temperate fruit crops
5. Explain the various pruning and training practices of temperate fruit crops
6. Enumerate the production constraints and recommend remedial measures in temperate fruit crop cultivation

Theory

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements. propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

Reference books

1. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. Ed. by K.V. Peter, New India Publishing Agency, New Delhi.
2. Bose, T. K., Mitra, S. K. and Rathore. D. S. 1998. Temperate Fruits - Nayaprakash, Calcutta
3. Chattopadhyay, T.K., 2001. A Text Book on Pomology (4 volumes), Kalyani Publishers, Ludhiana.

20HO2005- BREEDING OF FRUITS AND PLANTATION CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Objectives, concepts, propagation methods and breeding strategies of fruit and plantation crops
2. Advanced hybridization techniques in breeding of fruit and plantation crops
3. Breeding procedures and achievements in crop improvement of fruit and plantation crops

Course Outcomes:

On completion of this course, students will be able to

1. Outline the objectives, concepts, propagation methods of fruit and plantation crops
2. Understand plant genetic resources conservation and utilization in crop improvement
3. Develop breeding strategies for fruit and plantation crops
4. Acquire the knowledge in advanced hybridization techniques inbreeding
5. Apply methods of breeding in development of fruit and plantation crops
6. Enumerate achievements in crop improvement and the policies involved

Theory

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits. Pre breeding and breeding strategies, clonal selection, bud mutations, mutagenesis. Introduction to rootstock breeding, Introduction to Scion breeding, Gene silencing techniques: RNA interference(RNAi) technique, Virus Induced Gene Silencing (VIGS) technique, MicroRNA mediated Virus Induced Gene Silencing (MIR-VIGS), MicroRNA Induced Gene Silencing(MIGS), CRISPR-CAS systems and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistachionut, Apple, Pear, Plum, Peach, Apricot and Strawberry.

Suggested Reading:

1. Anil Kumar Shukla 2004. Fruit breeding approaches & Achievements. International Book Distributing Co.
2. Kumar N. 2015. Breeding of Horticultural Crops: Principles and Practices 2nd Revised & Expanded Ed. New India Publishing Agency.
3. Darbeshwar Roy. 2016. Breeding of Fruit Crops. Narosa Publishing House, New Delhi.
4. Ramachandra R.K., Maheshwar D.L., Shoba N. 2016. Breeding Of Spice & Plantation. Jaya Publishing House.
5. Gyana Root, Peter K.V. 2018. Genetic Engineering of Horticultural Crops. Academic Press. Elsevier.US.

20HO2006 - TROPICAL AND SUB-TROPICAL VEGETABLE CROPS
(18HO1005 Production Technology of Tropical and Subtropical Vegetables)

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Scope, production, and economic importance of tropical and subtropical vegetable crops
2. Varieties, hybrids, cultivation and management aspects of tropical and subtropical vegetables
3. Cropping systems, postharvest management and economics of tropical and subtropical vegetable cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Remember the area, production and productivity of tropical and subtropical vegetables
2. Describe the characteristics of varieties, and hybrids of tropical and subtropical vegetable crops
3. Understand the importance of nutrient, weed and irrigation management in tropical and subtropical vegetable cultivation
4. Explain the package of practices of commercially important tropical and subtropical vegetables
5. Develop and maintain commercial vegetable nursery
6. Evaluate the various vegetable-based cropping systems and post-harvest handling of vegetable crops

Theory

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems water and weed management nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and subtropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

Suggested Reading:

1. Thamburaj, S. 2014. Textbook of vegetable, tuber crops and Spices. ICAR, New Delhi
2. Choudhary, B. R., 2009. A Textbook on production technology of vegetables. Kalyani Publishers. Ludhiana.
3. Bose, T.K. 2002. Vegetable Crops. Nayaprakash. Kolkata
4. Hazra, P. 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi.
5. Gopal Krishnan, T.R. 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
6. Kamath, K.V. 2007. Vegetable Crop Production. Oxford Book Company. Jaipur
7. Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
8. Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
9. Yawalkar, K.S. 2008. Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur. 2004
10. Rana, M.K. 2008. Olericulture in India. Kalyani Publishers. Ludhiana
11. Hazra, P. 2006. Vegetable science. Kalyani Publishers. Ludhiana
12. Pratibha Sharma, 2007. Vegetables: Disease Diagnosis and Biomanagement. Aavishkar Publishers. Jaipur
13. Uma Shankar, 2008. Vegetable Pest Management Guide for Farmers. International Book Distribution Co. Publication. Lucknow.
14. Nath Prem, 1994. Vegetables for the Tropical Regions. ICAR New Delhi

15. Chadha, K.L. 1993. Advances in Horticulture. Malhotra publishing house. New Delhi
16. Shanmugavelu, K.G., 1989. Production Technology of Vegetable Crops. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
17. Choudhury, B. (ICAR). 1990. Vegetables. 8th edition, National Book Trust, New Delhi.
18. Singh, D.K., 2007. Modern Vegetable varieties and production technology. IBN publishers, International Book Distributing Co, Lucknow.
19. Premnath, Sundari Velayudhan and Singh, D.P., 1987. Vegetables for the tropical region. ICAR.

20HO2007-SPICES AND CONDIMENTS

Credits 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of cultivation and production of spices and condiments
2. Advances in the production technologies – irrigation, weed and nutrient management of spices and condiments
3. Postharvest management, marketing and economics of spices and condiments cultivation

Course Outcomes:

On completion of this course, students will be able to

1. Outline the concepts and propagation methods of spices and condiments
2. Understand the climate, soil requirement, nutrient and weed management of spices and condiments
3. Explain pruning and training methods, role of growth regulators and shade crops in the cultivation of spices and condiments
4. Acquire knowledge on essential oil extraction and value addition of spices and condiments
5. Describe harvest, postharvest and processing of spices and condiments
6. Know the marketing channels and economics of spices and condiments cultivation

Theory

History, scope and importance, present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micro-propagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction, marketing and economics of spice cultivation. Role of spice board and pepper, export promotion council, institutions and research centres in R&D. Crops: Cardamom, pepper, betel vine, ginger, turmeric, clove, nutmeg, cinnamon, kokum, star anise, flax seed, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

Practical

Spices: identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Quantitative and qualitative analysis of essential oil and oleoresins, identification of adulterants in spice produce. Visit to few spice farms and spice based industries.

Reference books

1. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.
2. Kumar, N, Md. Abdul Khader, P. Rangasamy, and Irulappan, I. 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil.
3. Nybe, E.V., Miniraj N. and Peter. K.V. 2007. Spices – Horticulture Science Series Vol. 5. New India Publishing Agency, New Delhi.
4. Shanmugavelu, K.G., Kumar N. and Peter K.V. 2005. Production Technology of Spices and Plantation Crops. Agrobios (India), Jodhpur.

20HO2008- BREEDING OF VEGETABLE, TUBER AND SPICE CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Floral morphology, anthesis and pollination in different types of vegetables and spices
2. Propagation methods and breeding strategies of vegetables, tuber and spice crops
3. Exploiting heterosis for quantitatively and qualitatively inherited traits

Course Outcomes:

On completion of this course, students will be able to

1. Understand the conservation and utilization of plant genetic resources in vegetable, tuber and spice crops
2. Distinguish the breeding strategies based on modifications in floral structures and pollination mechanisms
3. Understand the achievements in improvement of vegetables, tuber and spice crops
4. Analyse different propagation methods of tuber and spice crops
5. Adopt advanced breeding methods and produce high heterotic hybrids
6. Develop new varieties and hybrids of vegetables, tuber and spice crops

Theory

Breeding objectives and important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, disease resistance, abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops viz., Tomato, Brinjal, Bhendi, capsicum, Chilli, Cucurbits, Cabbage, Cauliflower, Tuber crops, Potato, Carrot, Radish, Spice crops (Ginger, Turmeric). Breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adaptability and stability.

Practical

Floral biology and pollination mechanism in self and cross-pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Suggested Reading:

1. Akhilesh Sharma, Vivekan Katoch, Susheel Sharma and Chanchal Rana. 2016. Practical on Vegetable breeding. Kalyani Publishers, New Delhi.
2. Dhaliwal, M.S. 2009. Vegetable Seed Production and Hybrid Technology. Kalyani Publishers, Ludhiana.
3. Dhaliwal, M.S. 2012. Techniques of Developing Hybrids in Vegetable Crops. Agrobios. Jodhpur.
4. Hari Hara Ram, 2013. Vegetable Breeding: Principle and Practices. Kalyani Publishers, Ludhiana.
5. Kallo, G. 1998. Vegetable Breeding (Vol. I to IV). CRC Press. Florida. 1988.
6. Singh, H.P. 2009. Vegetable Varieties of India. Studium Press (India) Pvt Ltd. New Delhi.
7. Singh, P.K. 2005. Hybrid Vegetable Development. CRC Press. Florida.
8. Vishnu Swaroop, 2014. Vegetable Science and Technology in India. Kalyani Publishers. Ludhiana.

20HO2009 TEMPERATE VEGETABLE CROPS

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Importance of temperate vegetables in nutrition and national economy
2. The production technologies of temperate vegetable crops
3. Post-harvest handling and marketing of temperate vegetable crops

Course Outcomes:

On completion of this course, students will be able to

1. Identify and describe hybrids and varieties of temperate vegetables
2. Understand the nutritional importance of cool season vegetables
3. Describe the scientific method of cultivation of major cool season vegetables
4. Apply remedial measures for nutritional and physiological disorders of temperate vegetables
5. Establish and maintain nursery for cool season vegetables
6. Postharvest management and marketing of temperate vegetables

Theory

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing of cabbage, cauliflower, knolkhol, sprouting broccoli, Brussels' sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, Vegetable kale.

Practical

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

Suggested Reading:

1. Thamburaj, S. 2014. Textbook of vegetable, tuber crops and Spices. ICAR, New Delhi
2. Choudhary, B. R., 2009. A Textbook on production technology of vegetables. Kalyani Publishers. Ludhiana.
3. Bose, T.K. 2002. Vegetable Crops. Nayaprakash. Kolkata.
4. Hazra, P. 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi.
5. Gopal Krishnan, T.R. 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
6. Kamath, K.V. 2007. Vegetable Crop Production. Oxford Book Company. Jaipur
7. Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
8. Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt. Ltd. New Delhi.
9. Yawalkar, K.S. 2008. Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur. 2004
10. Rana, M.K. 2008. Olericulture in India. Kalyani Publishers. Ludhiana
11. Hazra, P. 2006. Vegetable science. Kalyani Publishers. Ludhiana
12. Pratibha Sharma, 2007. Vegetables: Disease Diagnosis and Bio management. Aavishkar Publishers. Jaipur
13. Uma Shankar. 2008. Vegetable Pest Management Guide for Farmers. International Book Distribution Co. Publication. Lucknow.
14. Nath Prem. 1994. Vegetables for the Tropical Regions. ICAR New Delhi
15. Chadha, K.L. 1993. Advances in Horticulture. Malhotra publishing house. New Delhi
16. Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
17. Bose, T.K. 2003. Vegetable Crops. Nayaudyog publishers, Kolkata.
18. Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
19. Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

20HO2010- POTATO AND TUBER CROPS

Credit: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Economic importance and export potential of potato and tuber crops
2. Basic and modern cultural techniques to increase the yield and production of potato and tuber crops
3. Special practices, postharvest handling and marketing of potato and tuber crops

Course Outcomes

On completion of this course, students will be able to

1. Describe the cultivation practices of potato and other tuber crops
2. Understand the seed production technology of potato and tuber crops
3. Summarize the harvest, storage and postharvest handling techniques of potato and tuber crops
4. Identify and offer solutions to biotic and abiotic constraints (nutrient deficiencies, pest, diseases, and physiological disorders)
5. Understand the export potential and marketing channels of potato and tuber crops
6. Estimate cost of cultivation of potato and tuber crops.

Theory

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices and yield economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing. Crops to be covered – potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and intercultural use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Seed collection, working out cost of cultivation, project preparation of commercial cultivation.

Reference books:

1. Thamburaj, S. 2014. Textbook of vegetable, tuber crops and Spices. ICAR, New Delhi.
2. Choudhary, B. R. 2009. A Textbook on production technology of vegetables. Kalyani Publishers. Ludhiana.
3. Bose, T.K. 2002. Vegetable Crops. Nayaprakash. Kolkata
4. Hazra, P. 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi.
5. Gopal Krishnan, T. R. 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
6. Kamath, K.V. 2007. Vegetable Crop Production. Oxford Book Company. Jaipur
7. Dhaliwal, M.S. 2008. Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
8. Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
9. Yawalkar, K.S. 2004. Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur.
10. Rana, M.K. 2008. Olericulture in India. Kalyani Publishers. Ludhiana
11. Hazra, P. 2006. Vegetable science. Kalyani Publishers .Ludhiana
12. Pratibha Sharma, 2007. Vegetables: Disease Diagnosis and Biomanagement. Avishkar Publishers. Jaipur
13. Uma Shankar. 2008. Vegetable Pest Management Guide for Farmers. International Book Distribution Co. Publication. Lucknow.
14. Nath Prem. 1994. Vegetables for the Tropical Regions. ICAR New Delhi
15. Chadha, K. L. 1993. Advances in Horticulture. Malhotra publishing house. New Delhi
16. Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
17. Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
18. Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
19. Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.
20. Vincent Lebot, 2008. Tropical roots and tuber crops. CAVI.
21. Bradshaw, J.E. 2010. Root and tuber crops. Springer Publications.

20HO2011- POSTHARVEST MANAGEMENT OF HORTICULTURAL CROPS

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Scope and importance of post-harvest losses and processing of fruits and vegetables
2. Pre-harvest factors and post-harvest qualities of important fruits and vegetables
3. Different storage, packaging and transport of horticultural crops

Course Outcomes:

On completion of this course, students will be able to

1. Know the importance of post-harvest technology in horticultural crops
2. Remember the maturity indices of horticultural crops
3. Describe the post-harvest treatment of horticultural crops
4. Elaborate the pre-harvest factors responsible for postharvest deterioration of horticultural crops
5. Understand the different storage systems and types of packaging of horticultural crops
6. Determine the modes of transport for shipping of horticultural crops

Theory

Importance of postharvest technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants. Pre harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and biochemical changes, hardening and delaying ripening process. Postharvest treatments of horticultural crops. Quality parameters and specifications. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Methods of storage for local market and export. Pre-harvest treatment and pre-cooling, prestorage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging. Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.

Practical

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops, spices and cut flowers by using different packaging materials, methods of storage, and post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packing houses and cold storage units.

Suggested Reading:

1. Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
2. Wiils, McGlasson and Graham, J. 2007. Post-Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International
3. Stanley, J. K. 1998. Post-Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
4. Neetu Sharma and Mashkoor Alam, M. 1998. Post-Harvest Diseases of Horticultural Perishables. International Book Distributing Co., Lucknow.
5. Chadha, K. L. and Kalloo, G. 1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi.
6. Hulme, A.C. 1970. Food Science & Technology - A Series of Monograph. The Biochemistry of Fruits and their Products. Vol.-1. Academic Press London & New York.
7. Mitra, S. K. 1997. Post-Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International. Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
8. Thomposon, A. K. 1996. Post-harvest Technology of Fruits and Vegetables. Blackwell Science.
9. Battacharjee, S. K. and De, L. C. 2005. Post-Harvest Technology of Flowers and Ornamentals Plants. Ponteer Publisher, Jaipur, India.
10. Pruthi, J. S. 2001. Minor Spices and Condiments – Crop Managements and Post-Harvest Technology. ICAR, New Delhi.
11. Shanmugavelu, K. G., Kumar, N. and Peter K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios (India).
12. Saraswathy, S. *et. al.* 2008. Post-harvest Management of Horticultural Crops. Agribios (India). 81-7754-322-9.

13. Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4th ed.). US Davis, PHT Research and information Center.
14. Jacob John, P. 2008. A Handbook on Post Harvest management of Fruits and vegetables. Daya Publishing House, Delhi-1081-7035-532-X.
15. Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4 ed). US Davis, PHT Research and information Center.
16. <http://www.postharvest.com.au>
17. http://www.fao.org/infofoods/index_en.stm
18. www.postharvest.ucdavis.edu

20HO2012-PROCESSING OF HORTICULTURAL CROPS

Credits 1:0:2 (1+2)

Course Objectives:

To impart knowledge on

1. Scope and importance of fruit and vegetable preservation
2. Principles and methods of preservation techniques of fruits and vegetables
3. Different government schemes and laws in import and export of processed horticultural produce

Course Outcomes:

On completion of this course, students will be able to

1. Understand the postharvest losses and operations in India
2. Know the different unit operations in food processing industry
3. Remember the various preservation methods of horticultural crops
4. Describe the different preservation processes of fruits and vegetables
5. Understand the spoilage and quality control of processed products
6. Remember the food laws in export and import of processed horticultural produce

Theory

Importance and scope of fruit and vegetable preservation industry in India, food pipeline, losses in post-harvest operations, unit operations in food processing. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cost analysis of processed foods. Processing of plantation crops. Visit to processing units.

References:

1. Verma, L. R. and Joshi, V. K. 2000. *Post-Harvest Technology of Fruits and Vegetables*. Vol. I & II. Indus Publishing Co., New Delhi.
2. Post-harvest management and value addition of fruits and vegetables, ICAR publishers, Delhi.
3. A. K. Thompson, Fruits and Vegetables harvesting, handling, and storage, 3 edition, Blackwell publishing, John Wiley and Sons, UK.
4. Sharma C.P., Processing of horticultural crops, ICAR publishers, 2018.
5. Post-harvest technology: fruits and vegetables produce marketers, UCAID publications, 1998.
6. FAO - Training Manual No.17/2. 2007. *Prevention of post-harvest food losses: Fruits, Vegetables and Root crops*. Daya Publishing House, Delhi.
7. Morris, T. N. 2006. *Principles of Fruit Preservation*. Biotech Books, Delhi. 81-7622-116-3.
8. Rathore N.S., G.K. Mathur., Chasta S.S. 2012. *Post-Harvest Management and Processing of Fruits and Vegetables*. The Energy And Resources Institute

9. Srivastava, R. P. & Sanjeev Kumar. 2002. *Fruits and vegetable Preservation – Principles and Practice*. International Book Distributing Co., Lucknow

20HO2013- ORNAMENTAL HORTICULTURE

Credit :(1:0:1) (1+1)

Course Objectives:

To impart knowledge on

1. Production technology of ornamental crops
2. Design, establishment and maintenance of different types of gardens
3. Importance of flower arrangements, bonsai, terrarium, vertical gardens and their maintenance

Course Outcomes:

On completion of this course, students will be able to

1. Understand the significance of ornamental horticulture and floriculture industry in national economy
2. Describe the cultivation aspects and maintenance of ornamental plants
3. Design landscape and maintenance of different garden features including turf grass
4. Design and establish different types of gardens
5. Develop color themes for various living/ nonliving garden components and utilize garden adornments
6. Apply principles of ornamental horticulture in the design of terrarium, bonsai, flower arrangement and their maintenance

Theory

History, definitions, scope of ornamental horticulture, aesthetic values, floriculture industry, importance, area and production, industrial importance of ornamental plants and flowers. Importance, classification, design values and general cultivation aspects for ornamental plants viz. Annuals, biennales herbaceous perennials, grasses and bulbous ornamentals. Shrubs, climbers, trees, indoor plants, palms and cycads, ferns and sellagenellas, cacti and succulents. Importance, design and establishment of garden features/components viz. hedge, edge, borders, flowerbeds, bridges, paths, drives, fences, garden walls, gates, carpet bed, arbour, patio, decking, retaining walls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools, waterfalls, fountains, bog garden, avenue planting and children garden. Lawn types, establishment and maintenance. Importance of garden adornments viz. floral clock, birdbath, statues, sculptures, lanterns, water basins, garden benches etc. Importance of flower arrangement, Ikebana, techniques, types, suitable flowers and cut foliage, uses of vertical garden, bottle garden, terrariums, art of making bonsai, culture of bonsai and maintenance.

Practical

Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns and sellagenellas, palms and cycads and cacti and succulents. Planning and designing and establishment of garden features viz. lawn, hedge and edge, rockery, water garden, carpet bedding, shade garden, roof garden, study and creation of terrariums, vertical garden, study and practice of different types of flower arrangements, preparation of floral bouquets, preparation of floral rangoli, veni etc., Study of bonsai techniques, Bonsai practicing and training. Visit to nurseries and floriculture units.

Suggested Reading:

1. Bose, Chowdhury and Sharma. 1991. Tropical Garden Plants in color. Horticulture and allied publishers, 3D Madhab Chatterjee Street Kolkata.
2. Peter. K.V. 2009. Ornamental plants. New India publishing agency, Pitampura, New Delhi.
3. Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries pvt. Ltd.
4. Bimaldas Chowdhury and Balailal Jana. 2014. Flowering Garden trees. Pointer publishers, Jaipur. India.
5. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
6. Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
7. Bose, T.K. Mukherjee, D. 2004. Gardening in India. Oxford & IBH Publishers.
8. Chadha, K.L. and Chaudhary, B. 1986. Ornamental Horticulture in India. Publication and

Information division. ICAR, New Delhi

20HO2014- MEDICINAL AND AROMATIC CROPS

Credit: 2:0:1(2+1))

Course Objectives:

To impart knowledge on

1. Scope and importance of medicinal and aromatic crops
2. Production technology of medicinal and aromatic plants
3. Various extraction processes of drugs and essential oil and their therapeutic uses

Course Outcomes:

On completion of this course, students will be able to

1. Describe the cultivation practices of Medicinal and Aromatic plants (MAP)
2. Remember the different pharmaceutical and therapeutic uses of MAPs
3. Evaluate the MAPs for medicinal and therapeutic uses
4. Explain the different extraction methods of drugs and essential oils from MAPs
5. Remember the different uses of MAPs in developing organic agricultural products
6. Understand the marketing channels and economics of drugs and essential oils in MAPs

Theory

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition (Bioactive compounds), extraction, use, quantification and identification of a few important medicinal and aromatic plants, Therapeutic and pharmaceutical uses of important species. Post-harvest practices: harvesting and collection, drying and storage techniques, value addition and quality control (detection of adulterants) of drugs and essential oils. Medicinal plants: withania, periwinkle, rauwolfia, dioscorea, isabgol, opium poppy, ammimajus, belladonna, cinchona, pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum and other species relevant to the local conditions. Marketing and economics of drugs and essential oils in medicinal and aromatic plants. Bio prospecting of medicinal and aromatic plants for new medicines: Identification and collection of material by random and traditional (medicinal) approaches; Screening for particular bio-activities like insecticidal, weedicidal, anti-microbial and anti- tumor properties.

Practical

Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques, extraction, identification and quantification of drugs and essential oils. Value added product-using MAPS.

Suggested reading

1. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 2016. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
2. Farooqi A.A and B.S. Sreeramu. 2015. Cultivation of Medicinal and Aromatic Crops. Universities Press. 3-6-747/1/A, Himayat nagar, Hyderabad -500029.
3. Jitendra Singh. 2014. Spices and Plantation Crops. Aavishkar Publishers, Distributors, Jaipur.
4. Herbs, Spices and Essential oils –Post harvest operations in developing countries. UNIDO and FAO 2005
5. Extraction of Medicinal Plants , PDF notes developed by TNAU Professors
6. Extraction of Essential Oils from Aromatic Plants , PDF notes developed by TNAU Professors
7. Principles and Techniques of Practical Biochemistry, 5th edition, edited by Keith Wilson and John Walker, Cambridge University Press.
8. Modern Phytomedicine: Turning Medicinal Plants into Drugs. Edited by Iqbal Ahmad, Farrukh Aqil, Mohammad Owais. Published by Wiley-VCH Verlag GmbH & CO. KGaA

20HO2015- SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits: 1:0:1 (1+1)

Course Objectives:

To impart knowledge on

1. Role of nutrients in horticultural crop production
2. Soil fertility evaluation and soil testing methods
3. The concept and management of Integrated Nutrient Management

Course Outcomes:

On completion of this course, students will be able to

1. Elucidate the role of essential nutrients in horticultural crops
2. Identify nutrient deficiency symptoms in horticultural crops
3. Elaborate the role of microorganisms in enriching soil fertility by decomposing organic matter
4. Remember soil testing and soil fertility evaluation procedures
5. Understand the importance of bio-fertilizers in crop nutrition
6. Describe the concept of Integrated Nutrient Management in restoring soil fertility

Theory

Introduction to soil fertility and productivity- factors affecting soil fertility and productivity. Essential plant nutrient elements-functions, deficiency systems, transformations and availability. Acid, calcareous and salt affected soils – characteristics and management. Soil organic matter, Role of microorganisms in organic matter-decomposition – humus formation. Importance of C: N ratio and pH in plant nutrition, soil-buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Plant nutrient toxicity symptoms and remedial measures. Soil test crop response and targeted yield concept. Biofertilizers. Nutrient use efficiency and management. Secondary and micronutrient fertilizer. Fertilizer control order. Manures and fertilizers. Classification and manufacturing process. Properties, fate of major, and micronutrient in soils. Fertilizer use efficiency and management. Effect of potential toxic elements in soil productivity. Application of advanced techniques in fertilizer recommendation and application - Remote sensing, GIS, GPS, Precision agriculture, big data and Cloud computing.

Practical

Analysis of soil for organic matter, available N, P and K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils. Estimation of organic carbon content in soil. Determination of Boron and chlorine content in soil. Determination of Calcium, Magnesium and Sulphur in soil. Sampling of organic manure and fertilizer for chemical analysis. Physical properties of organic manure and fertilizers. Total nitrogen in urea and farmyard manure. Estimation of ammoniacal nitrogen and nitrate nitrogen in ammoniacal fertilizer. Estimation of water soluble P_2O_5 , Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate. Visit to fertilizer testing laboratory.

Reference books

1. John L. Havlin, Samuel L. Tisdale, Werner L. Nelson and James D. Beaton. 2016. (8th Edn). Soil Fertility and Fertilizers. Pearson Publishers. London.
2. Kolay, A.K. 2007. Manures and Fertilizers. Atlantic Publishers & Distributors (P) Ltd., Chennai.
3. Millar, C. E. 1955. Soil Fertility. John Wiley Publishers, New York
4. Panda, S.C. 2017. Soil Fertility and Nutrient Management. Agrobios (India) Publishers, Jodhpur.
5. Parker and Harold. J. 1991. Environmental handbook for fertilizer and agrichemical dealers. Tennessee Valley Authority, National Fertilizer and Environmental Research Center.
6. Yawalkar KS, Agarwal JP and Bokde S. 2002. Manures and Fertilizers (Ninth Edition). Agri-Horticultural Publishing House, Nagpur- 440010, India.

20HO2016- SOIL, WATER AND PLANT ANALYSIS

Credit: 1:0:1 (1+1)

Course objectives:

To impart knowledge on

1. Soil fertility, soil biology and problematic soils
2. Analysis and interpretation of plant nutrient content and quality of irrigation water
3. Soil and water pollution and reclamation

Course outcomes:

On completion of this course, students will be able to

1. Describe the methods of soil, plant and water sampling and processing for analysis
2. Evaluate the fertility status and biology of the soil
3. Identify and plan the management strategies for the problematic soils
4. Analyse and interpret the nutrient status of the plants
5. Evaluate the suitability of irrigation water and plan appropriate management strategies
6. Detect soil and water pollutants and recommend remedial measures

Theory

Methods of soil and plant sampling and processing for analysis. Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential. Use of radiotracer techniques in soil fertility evaluation. Soil microorganisms and their importance. Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values Quality of irrigation water. Radiotracer technology application in plant nutrient studies. Rapid tissue tests for soil and plant. Management of poor quality irrigation water in crop management. Soil and Water pollution.

Practical

Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Estimation of available macro and micronutrient elements in soils and their contents in plants. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of Calcium and Magnesium in soil and irrigation water. Determination of N, P, K, Ca, Mg, Sand micronutrients in plant samples. Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

Suggested Reading:

1. Tandon, H.L.S. 2013, Methods of analysis of soil, plant, water and fertilizers. FDCO, New Delhi.
2. Yawalkar, K. S. Agarwal, J. P. and Bokde, S., 1977. Manures and Fertilizers. Agri-Horticultural Publishing House, Nagpur.
3. Sehgal J. A., 2005. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
4. Jaiswal, P.C., 2006. Soil, Plant and Water Analysis (2nd Edition), Kalyani Publishers, Ludhiana.
5. Jackson M. L, 1967. Soil Chemical Analysis, Oxford and IBH Publishing Co., New Delhi.
6. Richards L A, 1968. Diagnosis and Improvement of Saline and Alkaline Soils. Oxford and IBH publishing Co. New Delhi (USDA Hand Book No. 60)
7. Chopra S.C. and Kanwar, J. S 1976. Analytical Agricultural Chemistry, Kalyani Publishers, Ludhiana.
8. Piper, C. S., 2014, Soil and plant analysis, Scientific publishers India.
9. Mushtaq A. Wan., 2014, Soil, plant and water analysis manual. Agrotech publishing company, Udaipur.
10. Gupta, P. K. 2013, Soil, plant, water and fertilizer analysis. Agrobios, India.
11. Durai. M. V. 2014, Hand book of Soil, plant, water, fertilizers and manure analysis. New India Publishing Agency.

20HO2017- ORGANIC FARMING

Credit: 2:0:1 (2+1)

Course Objectives:

To impart knowledge on

1. Historical, physio-chemical, biological and ecological basis of organic farming including various crop and soil management practices
2. Agronomic practices and farming techniques of different crops and cropping systems under organic farming
3. The concepts related to legislation, inspection, certification, and marketing of organic produce

Course Outcomes:

On completion of this course, students will be able to

1. Remember the concepts of organic farming
2. Understand the requirements for organic production of crops
3. Elaborate the organic composting methods
4. Apply Integrated strategies by using non-chemical methods for management of pests, diseases and weeds
5. Understand the certification, labelling and accreditation processes involved in organic cultivation
6. Analyse different marketing strategies of organic farm produce

Theory

Introduction, concepts, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, bio-fertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labelling and accreditation processors, marketing, exports.

Practical

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post-harvest management.

Suggested Reading:

1. Dahama, A.K. 2007. Organic farming for sustainable agriculture. Agrobios (India), Jodhpur.
2. Arun. K. Sharma. 2011. Handbook of Organic farming. Agrobios (India), Jodhpur.
3. Palaniappan, S.P. and K.Annadurai. 2010. Organic farming – Theory and Practice. Scientific Publishers. Jodhpur.
4. Thapa, U and P. Tripathy. 2006. Organic farming in India- Problems and Prospects. Agrotech publishing agency, Udaipur.
5. Veeresh, G.K. 2006. Organic farming. Foundation Books. New Delhi.
6. Purshit, S.S. 2006. Trends in Organic Farming in India. Agros Bios (INDIA), Jodhpur.
7. Thampan, P. K. 1995. Organic Agriculture. Peckay tree Crops Development Foundation, Cochin, Kerala.
8. Sathe, T.V. 2004. Vermiculture and Organic Farming. Days Publishing House, New Delhi.

20HO2018- HORTI-BUSINESS MANAGEMENT

Credits: 2:0:0 (2+0)

Course Objectives:

To impart knowledge on

1. Farm and business management principles of horticultural crops
2. Economic principles of organization and management of businesses with emphasis on choice of optimal enterprise combinations
3. Functional areas of business management of horticultural produce

Course Outcomes:**On completion of this course, students will be able to**

1. Recall farm and business management concepts
2. Analyse the time value of money
3. Apply economic principles in farm management
4. Understand the functional areas of management
5. Gain knowledge on planning and marketing
6. Prepare financial statements, budgeting and project management

Theory

Farm management - definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concepts, curves and functions – factor-factor relationship, product-product relationship and factor-product relationship, principles of opportunity cost/ equi-marginal returns and comparative advantages, time value of money, economies of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control, responsibility, power authority and accountability. Direction – guiding, leading, motivating, and supervising. Coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation and evaluation measures.

Reference books

1. Allied L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
2. Barry, P. J., Hopkins, J. A. and Baker, C. B. 1995. Financial Management in Agriculture, 6th ed. Interstate Publishers, Inc. Danville IL.
3. Benjamin Mc Donald, P. 1985. Investment Projects in Agriculture- Principles and Case studies. Longman Group Limited. Essex. UK
4. Dewett, K. K. and Navalur, M. H. 2006. Modern Economic Theory. S. Chand & Sons, New Delhi.
5. Gittiner, J. P. 1982. Economic analysis of agricultural projects. The John Hopkins University Press Baltimore, USA.
6. Heady Earl O and Herald R. Jenson. 1954. Farm Management Economics. Prentice Hall, New Jersey, USA
7. Jain, S. P. 2006. Financial Accounting. Kalyani Publications, Ludhiana.
8. Johl, S.S. and Kapur, J.R. 2006. Fundamentals of Farm Business management. Kalyani Publishers, New Delhi
9. Karan S. and Kahlon, A. S. 1981. Economics of Farm Management in India. Theory and Practice. Allied Publishers Pvt. Ltd, New Delhi.
10. Koontz, H. 2004. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
11. Shapiro E. 2010. Macroeconomic analysis. Galgotia Publications Delhi
12. Subba Rao, P. 2010. Human Resource Management. Himalaya Publications.
13. Thomas, P.C. 1990. Managerial Economics, 9th Ed. Kalyani Publishers, New Delhi
14. Pandey. U.K. 1990. An Introduction to Agricultural Finance. Kalyani Publishers New Delhi

20HO2019 - Rural Horticultural Work Experience (RHWE)

Credits 0:20 (0+20)

Introduction

The Honorable Prime Minister of India launched Student READY™ programme on 25th July 2015. The term “READY” refers to “Rural Entrepreneurship Awareness Development Yojana”. To reorient graduates of agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the programme as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

There are two components:

III. STUDENT READY – Placement in Industries 0:0:10 (0+10)

IV. STUDENT READY – Placement in Villages 0:0:10 (0+10)

The Rural Horticultural Work Experience (RHWE) helps the students primarily to understand the rural situations, status of agricultural technologies adopted by farmers, prioritize the farmers’ problems and to develop skills & attitude of working with farm families for overall development in rural area.

The students will undertake this program during the seventh/eighth semester for a maximum duration of 20 weeks with a weightage of 0+20 credit hours in two parts namely RHWE and IP. RHWE will consist of general orientation and on campus training by different faculty followed by village attachment/unit attachment in University/ College/ KVK or a research station. Under IP, the students would be attached with the agro-industries to get an experience of the industrial environment and working. Due weightage in terms of credit hours will be given depending upon the duration of stay of students in villages/agro industries. At the end of RHWE & IP, the students will be given two week for project report preparation, presentation and evaluation. The students would be required to record their observations in field and agro-industries on daily basis and will prepare their project report based on these observations.

Course Objectives:

To impart knowledge on

1. Socio-economic conditions of the farmers and their problems
2. Extension teaching methods in transfer of technology to enhance the communication skills of students
3. Functioning of horti-based industries

Course Outcomes:

On completion of this course, students will be able to

1. Understand the horti-based farming systems
2. Acquaint themselves with farmers’ problems and situations
3. Acquire knowledge on horticultural innovations through demonstrations and farmers training/ field day arranged with help of Horticultural extension officers
4. Know the government, private and NGOs involved in the rural development activities of the villages
5. Survey the villages for undertaking socio-economic studies
6. Understand the Horti based industrial operations

Course Content

Unit I: Rural Horticultural Work Experience (RHWE)

The unit enables students to study of Village and Farm households (Agro-Ecological and Socio- Cultural Economic, Setting), particularly:

- Village settlement pattern, demography, climate, land utilization pattern, resources inventory, infrastructure facilities, rural institutions, organizations, groups, customs, beliefs and value systems.
- Study of cropping pattern, cropping systems, extent of adoption of latest technologies and constraints –cereals, millets, pulses, oilseeds and horticultural crops–productivity – Decline in productivity – Yield gap – constraints in production. Specific study on the following:
 - i. Agronomic Intervention.
 - ii. Plant protection Intervention.

- iii. Soil Improvement Intervention.
- iv. Fruit and Vegetable Production Intervention.
- v. Food Processing and Storage Intervention.
- vi. Animal Production Intervention.
- Understanding social participation, leadership pattern, scientific orientation and role of women and youth in agricultural development.
- Extension methods and Audio-visual Aids – Practicing individual, group and mass contact methods.
- Studying the existing Indigenous Technical Knowledge and its importance for technology generation.
- Understanding the communication pattern in villages.
- Studying farm women associations / farmers associations / commodity groups and learning their functioning and use of their services for dissemination.
- Conducting need-based skill demonstrations in the villages.
- Developing Whole Village Development Plan.
- Contacting individual farmers to assess the farming systems practiced by marginal, small, medium, big farmers and farm Women.
- Preparation of Individual farm plan.
- Documentation of success stories of the farmers.
- Study of University/College/KVK Research and Extension activities and Agricultural development schemes in the villages.

Unit II: Study under Industry Placement

- Industries to be studied include seed/sapling production, pesticides- insecticides, post – harvests –processing –value addition, Agri-finance institutions, dairy, poultry,etc.
- General information about the Agro-Industry – Nature of business – Brief history of the firm - Licensing and other legal aspects of the firm.
- Study of structure, functioning, objective and mandates of the industry.
- Study of various processing units and hands-on trainings under supervision of industry staff.
- Employment generated by the industry.
- Contribution of the industry-promoting environment.
- Learning business network including outlets of the industry.
- Skill development in all crucial task of the industry.
- Documentation of the activities and task performed by the students.
- Performance evaluation, appraisal and ranking of students.

RHWE Components and Activities:

Component	Activity	No. of weeks*	Credit Hours
Preparation	General orientation & On-campus training by different faculty members	2	
RHWE	Village Placement (including exposure to Extension Centre, Univ. KVK, Research station & NGO)	8	10
	(Agro) Industry Placement	8	10
Evaluation	Project Report Preparation, Presentation and Viva-Voce	2	

*as per the ICAR V Dean committee Recommendation (P:638)

Evaluation of student RHWE program

- i. Students shall be evaluated component-wise under village attachment/ agro- industrial attachment.
- ii. The university will designate a RHWE Program Coordinator who along with Mentor-teachers for the students' groups would become the committee of evaluators. While marking the performance, due weightage to the observations made by the Farmers/ Horticultural Extension Worker / Scientists/Agro-industrial Officer and the Program

Coordinator with whom they are attached will be given. The students will be evaluated for 100 marks. The outline of evaluation and distribution of marks will be as follows:

Component	Village Attachment	Horti. Extension Centre Attachment	KVK/Research / NGO Attachment	Agro-Industry	Total Mark
Participation, Oral Presentation and Work Diary maintained	30	5	5	15	55
Preparation Report	10	5	5	10	30
Overall Exhibition**					15
Total	40	10	10	25	100

**Final Display and Exhibition of the learning outputs/findings/visuals/charts/posters/ Models before the evaluation committee

Note : Only one examination (End semester) will be conducted at end of the semester for 100 marks

x. Performance during placement:

The committee led by the RHWE Coordinator and Mentor-teachers, who frequently visits/villages in rotation will assess the students' performance during the placements in villages. In case of placements in industries/institutions, the committee in consultation with the concerned designated person in the host institute will assign the marks for the performance of students.

xi. Group Presentation and Viva-voce:

After completion of student's placements in rural areas and institutions/industries, the Committee will have group discussion session to assess each student's level of participation and interaction abilities based on experience gained in RHWE. Each student along with the students group to which he belongs will give a brief presentation on the work that has been carried out, experience gained and points for future consideration. A Viva- voce examination will be conducted for each student on the relevant topics to know the overall impact of RHWE on the student, on the farming community and on the Institutions. Using the outputs and findings from various activities carried out in the filed programmes, the student groups shall put up a small exhibition/display to be seen, observed and scrutinized by the evaluation committee.

xii. Attendance & diligence:

Marks are given for student's presence and attentiveness in classes conducted on the campus and placements in rural areas/institutions.

xiii. Work diary:

Evaluation of work diary indicating brief description of activities carried out by the student every day during the placements.

xiv. Practical record/Project report:

For each component, the student will maintain a practical record. The record will have detailed description for all the topics specified. The description will be on statement of tasks carried out, sequential steps/procedure followed in completion of the task, approaches used to accomplish the task, impact of the task on the intended audience, feedback obtained and lessons learnt. For the courses where placements in other institutions/industries are made, the student will write report with description on background of the institution as per topics given in the syllabus.

xv. Since the credit hours allotted to the RHWE program are grade-based, the minimum condition of attendance and grading system will apply for the program as will be applicable to other courses.

xvi. It is expected that at the end of RHWE program, the students should gain familiarity and competency for working with rural stakeholders viz, Farmers, Development Departments,

Agro-industries, NGOs and others. The evaluation committee must ensure percentage increase in this competency at the end & successful organization of all RHWE programs.

Monitoring & Coordination

For each batch, there will be a designated RHWE coordinator and concerned Mentor-teachers of the batch/student groups who will make periodical visits the rural- placement areas to guide, supervise and monitor the work of students as well as to evaluate the performance of the students on the concerned subject. They will also stay overnight once in a fortnight to support the students during the extension educational activities conducted during evening hours.

The RHWE coordinator in liaison with KVK/ZRS/NGO and other developmental departments will facilitate visit of Mentor-teachers to villages after the return of the students to ensure continued technical support to farmers, till the 'end of crop season. The Dean/ HoD of the college will provide necessary resources-material, finance, man power, vehicles, etc. and ensure participation of the designated Mentor- teachers in the RHWE activities. Coordination Committee for RHWE may consist of:

i. Dean of the Faculty	-Chairman
ii. HOD, Agriculture	-Convener
iii. Senior Teacher of Extension Education	- RHWE Coordinator
iv. Student Counselor/Mentor	-Member
v. Representative of State Dept. of Agriculture (AO):	-Member
vi. Village Leader / Farmer (off-campus representation. (1)	-Member
vii. Agro-industry Representative	-Member
viii. Group Facilitator (Student representatives)	-Member

Other General Guidelines:

- A mid-term appraisal will be taken up by the Heads of Departments and the Evaluation Committee for reviewing the work carried out by the students.
- Periodical visits will have to be made by Evaluation Committee members to the locations to monitor, guide and supervise the students.
- An exhibition will be conducted highlighting the experiential learning process, depicting the outcomes, supported with charts, posters, specimens, models, etc., on completion of the programme.
- Mass media coverage may be given for the different activities undertaken by the students. Local prominent persons may be invited for RHWE programmes in villages.
- Appropriate documentation has to be ensured at all stages. Photographs/video coverage and newspaper messages should be ensured and arranged in possible locations/events.

Instructions to students

- No student should leave the location during this period on any account even during holidays.
- A movement register will have to be maintained indicating the date, time, places, purposes of visit and expected time of arrival.
- Students while leaving for respective villages/Agriculture Dept office/Industry should leave a message about their programme in the movement register maintained for this purpose where they are staying.
- They should maintain an observation note for recording on the spot details during their visits to record daily activities and programmes.
- All the students will be given a Practical Manual for which the details should be collected during the course of the programme.
- On reaching the location of their stay, all students should intimate the Head of the Department / RHWE Coordinator and Mentor-Teacher about their arrival.
- The RHWE Coordinator and Mentor-Teachers will guide the students about the villages identified for each student and details of the place of stay.
- The Group Facilitators will guide the students in the selection of NGO, ADA office, and

Agro-Industry for each group in and around the location.

- All students should report to the Professor and Head, Department of Agriculture, RHWE-Coordinator and Mentor-Teachers and the Group Facilitators about the particulars regarding the villages allotted to them, the names and addresses of the contact farmer in the villages and work carried out every week.
- Students should avoid unnecessary exchange of ideas with the local people on politics, religion, caste, etc., which will spoil the harmony of programme.
- Students should contact maximum number of farmers in the locality and participate in the farm operations and record the observations about marginal, small and big farmers and one farmwoman.
- Students should avoid doing anything which may damage the image of students, as well as students institution.
- Head of the Department of Agri, RHWE Coordinator and Mentor -Teachers will make surprise inspection to know the students activities.
- In case of emergency, students may contact Professor and Head, Department of Agricultural/ RHWE Coordinator/Mentor-Teachers.
- The mobile numbers of Group facilitators may be obtained by students.
- The students should keep in readiness their observation note and Practical Manual for evaluation on the final day of RHWE.

References:

1. ICAR Fifth Deans' Committee Report, Agricultural Education Division, Indian Council of Agricultural Research (ICAR)", New Delhi.
2. Academic Information Hand Book, 2019, KITS, Coimbatore.
3. RHWE manual, guidelines of TNAU, Coimbatore.
4. Personal discussion with TNAU experts and brain storming contribution from Agri. Faculty of KITS.

20AT2002 -Engineering Properties of Agricultural Produce

Credits 1:0:1

Course Objectives

To impart knowledge on

1. Engineering properties of biological materials
2. Flow behavior of different food materials
3. Applications of electrical properties in food engineering

Course Outcomes

The students will be able to

1. Understand engineering properties of food materials
2. Determine the physical and frictional properties of food materials
3. Analyse the aerodynamic properties of agricultural products
4. Identify the structure and chemical composition of food materials
5. Address the problems in the bio material conveying systems
6. Examine the thermal properties, rheological properties and electrical properties of food

Theory

Classification and importance of engineering properties of agricultural produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables. Thermal properties; coefficient of thermal expansion, friction in agricultural materials; static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures.

Practical

Determination of the shape and size of grains, fruits and vegetables. Determination of bulk density and angle of repose of grains, determination of the particle density/true density and porosity of solid grains. Finding the co-efficient of external and internal friction of different crops, finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel, finding the thermal conductivity of different grains, determination of specific heat of some food grains, determination of hardness of food material and determination of viscosity of liquid foods.

Text Books

1. Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers, New York.
2. Singhal OP and Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.
3. Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.

Reference Books

1. Mohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers, New York.
2. Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.

20AT2003 - Remote Sensing and GIS Applications (Electives)**Credits 2:0:1****Course Objectives:**

To impart knowledge on

1. Concepts and applications using Remote Sensing, GIS and GPS technologies
2. Storing, managing digital data for planning and development
3. Applications of Remote Sensing and GIS in agriculture, soil and water resources

Course Outcomes:

The students will be able to

1. Understand the remote sensing principles
2. Analyse the remote sensing systems satellite data processing and available data products
3. Understand decision making process using DBMS
4. Interpret aerial photographs and satellite imagery
5. Utilize the advanced techniques in addressing the real world problems
6. Apply their skills on RS and GIS in agriculture, soil and water resources

Theory

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water, spectral signatures; different types of sensors and platforms; contrast and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attributed at a

management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; use of software for image interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study of various features of GIS software package; scanning, digitization of maps and data editing; data base query and map algebra. GIS supported case studies in water resources management.

Text Books

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.

Reference Books

1. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education Limited, UK.
2. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
3. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
4. Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
5. Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

20AT2004 - Human Engineering and Safety (Electives)

Credits 2:0:1

Course Objectives

To impart basic knowledge on

1. Ergonomics by understanding the fundamental concepts
2. Ergonomic aspects in the design of farm machinery for more output and safety of human beings
3. Human engineering and safety

Course Outcomes:

The students will be able to

1. Explain the psychology of human behaviours as it relates to workplace safety
2. Identify ergonomic hazards
3. Recommend appropriate controls
4. Relate the human and workplace factors
5. Understand the workplace safety
6. Apply the knowledge in design of farm machinery in ergonomic aspect

Theory

Importance of ergonomics and its application in agriculture; Energy liberation in human body; Assessment of energy expenditure- direct calorimetry, Indirect calorimetry- Assessment by oxygen consumption; Techniques of measuring oxygen consumption; Assessment by heart rate and calibration; Assessment by subjective rating of perceived effort - Overall discomfort score and BPDS; Basal metabolism and work metabolism; Assessment of workload; Assessment of Individual's maximal work capacity. Anthropometry; Anthropometric data and measurement techniques; Anthropometric dimensions and strength parameters; Causes of variability of anthropometric data; Analysis of anthropometric data and use of percentiles. Biomechanics of motion. Vibration- hand arm vibration and whole body vibration, physiological effects; Noise and its physiological effects. Human factors in system development – concept of systems; basic processes in system development; performance reliability, human performance; Metabolic system, human energy machine, Human metabolism and

work; Energy liberation in human body; Energy for muscle work; Assessment of energy expenditure-direct calorimetry, Indirect calorimetry; Techniques of measuring oxygen consumption; Assessment of workload; Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill; use of respiration gas meter from human energy point of view. Use of Heart Rate Monitor. Study of general fatigue of the subject using Blink ratio method, familiarization with electro-myograph equipment, anthropometric measurements of selected subjects. Optimum workspace layout and locations of controls for different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.

Text Books

1. Astrand, P.O and K., Rodahl. 1977. Text book of work physiology, McGraw Hill, New York.
2. Bridger, R.S, 1995. Introduction to Ergonomics, McGraw Hill, New York.
3. Dul, J. and B., Weerdmeester. 1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
4. Mark, S. S. and E. J., McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.

Reference Books

1. Mathews, J. and A. A. Knight. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.

20AT2005 - Waste and By-products Utilization (Electives)

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. Proper utilization of agricultural waste and by-products
2. Development of value added products from wastes
3. Waste treatments and disposal techniques

Course Outcomes:

The students will be able to

1. Recommend suitable waste management techniques
2. Explain techniques for by-products utilization from food processing industries
3. Elaborate the waste management and effluent treatment
4. Learn advanced waste water treatment processes
5. Appraise the treatments and disposal of solid waste
6. Understand various legalizations on food industry and its environmental impact

Theory

Types and formation of by-products and waste; magnitude of waste generation in different food processing industries; uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc., concept, scope and maintenance of waste management and effluent treatment, temperature, pH, oxygen demands (bod, cod), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin- composting, pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, secondary treatments: biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, tertiary treatments: advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal, assessment, treatment and disposal

of solid waste; and biogas generation, effluent treatment plants, environmental performance of food industry to comply with ISO- 14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Study about briquetting of agricultural residues, Estimation of excess air for better combustion of briquettes, Study of extraction of oil from rice bran, Study on bioconversion of agricultural wastes, Recovery of germ and germ oil from by-products of cereals, Visit to various industries using waste and food by-products.

Text Books

1. Oreopoulou, V.andW., Russ(Edited).2007.UtilizationofBy-productsandTreatmentof waste in the Food Industry. Springer Science & Business media, LLC 233 NewYork.
2. Markel, I.A. 1981. Managing Livestock Waste, AVI PublishingCo.
3. Pantastico, ECB. 1975. Post-Harvest Physiology, Handling and utilization of Tropical and Sub- tropical fruits and vegetables, AVI Pub.Co.
4. Shewfelt, R.L. and S.E., Prussi, 1992. Post-Harvest Handling – A Systems approach, Academic PressInc.

Reference Books

1. USDA. 1992. Agricultural Waste Management Field Hand book. USDA, WashingtonDC.
2. Weichmann, J. 1987. Post Harvest Physiology of vegetables, Marcel and DekkerVerlag.
3. Joshi, V.K. and S.K., Sharma. Food Processing Waste Management: Treatment & Utilization. New India PublishingAgency.
4. Prashar,A.andB.,Pratibha.2008.IndustrialSafetyandEnvironment.S.K.Kataria and sons, NewDelhi.
5. Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, NewDelhi.
6. Bhatia, S.C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, NewDelhi.

20AT2006 - INTRODUCTORY SOIL AND WATER CONSERVATION ENGINEERING

Credits 1:0:1

Course Objectives

To impart knowledge on

1. Concept of soil and water conservation
2. Various causes for soil erosion
3. Soil and water conservation measures

Course Outcomes

The students will be able to

1. Understand basic concepts of soil and water conservation
2. Explain the gully erosion control measures
3. Measure the soil loss using different techniques
4. Explain the water harvesting techniques
5. Understand the mechanics of wind erosion
6. Explain the different control measures of wind erosion

Theory

Introduction to soil and water conservation causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal soil loss equation. Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed waterways and their design. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

1. Calculation of erosion index. Estimation of soil loss
2. Measurement of soil loss

3. Preparation of contour maps
4. Design of grassed waterways
5. Design of contour bunds
6. Design of graded bunds
7. Design of bench terracing system
8. Problem on wind erosion

Text Books

1. Mahnot, S.C. 2014. Soil and water conservation and watershed management. International Books and Periodicals Supply Service, New Delhi.
2. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
3. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of soil and water conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Reference Books

1. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
2. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

20AT2007 - Credit Seminar**Credits: 0:0:1****Course Objectives:**

Analyse a range of new material ideas and concepts of emerging technologies.

Course Outcomes

The students will be able to

1. Build up presentation skills
2. Discuss the subject matter
3. Build up listening skills
4. Take part in arguments
5. Elaborate the applicability of concept
6. Develop leadership quality

Evaluation Pattern for Courses 20AT2007

The evaluation pattern is given below to get approval from the standing committee.

Attendance	= 10*
Internal assessment/Presentation	= 50
Evaluation of report	= 40
Total	= 100

(Note: *80% attendance is required for eligibility to award marks/grade)

REVISED COURSE OBJECTIVES AND OUTCOMES FOR APPROVED COURSES

Sl. No.	Course Code	Name of the Course	Credits
1	18AG1001	Fundamentals of Agronomy	(3+1)
2	18AG1002	Agricultural Heritage	(1+0)
3	18AG1003	Introductory Agricultural Meteorology and Climate Change	(1+1)
4	18AG1004	Fundamentals of Plant Biochemistry	(2+1)
5	18AG1005	Agricultural Microbiology	(2+1)
6	18AG1006	Rural Sociology and Educational Psychology	(2+0)
7	18HO1001	Fundamentals of Horticulture	(2+1)
8	18AG1007	Irrigation Water Management	(1+1)
9	18AG1008	Principles of Genetics and Cytogenetics	(2+1)
10	18AG1009	Fundamentals of Crop Physiology	(2+1)
11	18AG1010	Fundamentals of Plant Pathology	(2+1)
12	18AG1012	Fundamentals of Agricultural Economics	(2+0)
13	18AG1013	Fundamentals of Soil Science	(2+1)
14	18AG1014	Fundamentals of Agricultural Extension Education	(2+1)
15	18AG1016	Introductory Agro Forestry	(1+1)
16	18AG2001	Principles of Plant Breeding	(2+1)
17	18AG1011	Fundamentals of Entomology	(3+1)
18	18AG2002	Crop Production Technology - I (Kharif Crops)	(1+1)
19	18AG2003	Agricultural Finance and Cooperation	(2+1)
20	18AG2004	Production Technology of Vegetables	(1+1)
21	18AG2007	Farming Systems and Sustainable Agriculture	(1+0)
22	18AG2015	Environmental Studies and Disaster Management	(2+1)
23	18AG2029	Principles of Organic Farming	(1+1)
24	18AG2005	Livestock and Poultry Management	(3+1)
25	18AG2008	Crop Production Technology-II (Rabi Crops)	(1+1)
26	18AG2009	Production Technology for Ornamental Crops and Landscaping	(1+1)
27	18AG2010	Production Technology of Fruits and Plantation Crops	(1+1)
28	18AG2011	Principles of Seed Technology	(1+1)
29	18AG2012	Problematic Soils and their Management	(2+0)
30	18AG2013	Agricultural Marketing, Trade and Prices	(2+1)
31	18AG2014	Introduction to Biotechnology	(2+1)
32	18AG2016	Medicinal, Spices and Aromatic Plants	(1+1)
33	18AG2017	Study Tour – I	(0+1)
34	18AT2042	Renewable Energy and Green Technology	(1+1)
35	18AG2018	Practical Crop Production-I (Kharif Crops)	(0+2)
36	18AG2019	CROP IMPROVEMENT – I (Kharif)	(1+1)
37	18AG2020	Manures, Fertilizers and Soil Fertility Management	(2+1)
38	18AG2021	Diseases Of Field & Horticultural Crops and their Management – I	(2+1)
39	18AG2022	Principles of Integrated Pest and Disease Management	(2+1)
40	18AG2023	Pests of Crops and Stored Grains and their Management	(2+1)
41	18AG2024	Precision Farming	(1+1)
42	18AG2025	Entrepreneurship Development and Business Management	(1+1)
43	18AG2026	Intellectual Property Rights	(1+0)
44	18HO1003	Propagation and Nursery Management for Horticultural Crops	(2+1)
45	18AG2006	Agri Informatics	(1+1)
46	18AG2027	Rainfed Agriculture and Watershed Management	(1+1)
47	18AG2028	Practical Crop Production-II (Rabi Crops)	(0+2)
48	18AG2030	Diseases of Field and Horticultural Crops and their Management – II	(2+1)

49	18AG2031	Management and Value addition of Fruits and Vegetables	(2+1)
50	18AG2032	Crop Improvement – II (<i>Rabi</i>)	(1+1)
51	18AG2033	Management of Beneficial Insects	(1+1)
52	18AG2034	Farm Management, Production & Resource Economics	(1+1)
53	18AG2035	Principles of Food Science and Nutrition	(2+0)
54	18AG2036	Study Tour – II	(0+1)
55	18AG2037	Spices, Medicinal and Aromatic Crops	(2+1)
56	18AG2038	Precision Farming and Agro Informatics	(2+1)

18AG1001 - FUNDAMENTALS OF AGRONOMY

Credits: 3:0:1

Course Objectives:

To impart knowledge on

1. Cultivation of crops, growing seasons, and crop classification
2. Planting, growth and development, crop nutrition, fertilizer recommendation and weed management
3. Crop rotation, distribution and adaptation, crop management, harvesting and threshing of crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand and outline the basics of crop characteristics and its classification
2. Explain the crop growth phases cultivation practices
3. Identify crops, seeds, fertilizers, pesticides, farm /tillage implements
4. Acquire scientific knowledge on weeds, its impacts on crop growth and integrated weed management
5. Apply fundamentals of growth concepts, factors influencing and its relationship to nutrients applied
6. Describe crop rotation, its principles and apply knowledge of crop management techniques in crop production

18AG1002 - AGRICULTURAL HERITAGE

Credits: 1:0:0

Course Objectives:

To impart knowledge on

1. Importance and origin of agriculture, agricultural systems and resources in India
2. Agricultural development and Green revolution in India
3. Agricultural education, Farm mechanization and Women empowerment in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand agricultural heritage of India, agricultural resources and development of Indian agriculture from ancient to modern era
2. Compare indigenous traditional knowledge in agriculture and crop voyage in India and the world
3. Describe gender perspective, tasks of farm women, women empowerment and self-help groups
4. Apply Indigenous Traditional Knowledge (ITK) in modern agricultural practices
5. Visualize transition of agriculture from past to present
6. Acquire knowledge on gender issues in agriculture for women empowerment and implement women-friendly agricultural technologies

18AG1003 - INTRODUCTORY AGRICULTURAL METEOROLOGY AND CLIMATE CHANGE

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. Agricultural meteorology and its role in crop production
2. Atmospheric weather variables, climatic factors and their measurements
3. Climate change and its effect on crop production

Course Outcomes:

On completion of this course, students will be able to

1. Understand significance of agricultural meteorology, climate and weather
2. Explain the various atmospheric weather variables and its significance in crop production
3. Discuss crop weather relationships for efficient crop production
4. Acquire knowledge on weather forecasting techniques and effect of climate change on crop production
5. Describe artificial rainmaking, precipitation, monsoons and its importance in Indian Agriculture
6. Discuss global warming, and its effect on regional and national agriculture

18AG1004 - FUNDAMENTALS OF PLANTBIOCHEMISTRY

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Role of biochemistry in medicine, agriculture and pharmaceutical industries
2. Importance of Biomolecules with structure classification and function
3. Synthesis and storage of metabolic energy

Course Outcomes:

On completion of this course, students will be able to

1. Understand the importance of biomolecules in medicine, agriculture, pharmaceuticals and ethics
2. Recall the role of biomolecules in photosynthesis, protein synthesis and DNA synthesis
3. Analyse the structure and classification of biomolecules
4. Remember the developments in biochemistry
5. Explain the overall aspects of integration of metabolic processes
6. Apply knowledge on the structure of carbohydrates, proteins, vitamins, nucleic acids and lipids in drug discovery

18AG1005 - AGRICULTURAL MICROBIOLOGY

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Importance and role of microorganisms in agriculture and understanding of soil microbiology
2. Classification of microorganisms, functions and its role in genetic crop improvement
3. Role of microbes in soil fertility, human welfare, production of silage, biofertilizers, biopesticides, biofuels, and biodegradation of agricultural wastes

Course Outcomes:

On completion of this course, students will be able to

1. Comprehend the importance and role of microbes in agricultural production
2. Understand principles of microscopy, sterilization techniques and nutrient media preparation
3. Enumerate microbial load in soil and perform isolation, culturing and purification of microbes
4. Describe role of microbes in enhancing soil fertility
5. Analyse genetic improvement of crop plants and transformation methods using microbes

6. Apply knowledge and develop biofertilizers, biopesticides, biofuels, and biowaste degradation

18AG1006 - RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY

Credits: 2:0:0

Course objectives:

To impart knowledge on

1. Sociological behaviour of rural population
2. Functions of rural society social stratification and social changes
3. Behavioral pattern, theories of motivation, personality, Intelligence Quotient (IQ)

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic concepts of rural sociology
2. Remember the significance of rural sociology in agricultural extension
3. Analyse the pattern of behavioral changes of rural society under critical circumstances
4. Apply the concepts of educational psychology in agriculture
5. Apply knowledge on functions of social institutions
6. Adopt the concept of agricultural extension practices in day to day life of farmers

18HO1001 - FUNDAMENTALS OF HORTICULTURE

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The scope and importance of horticultural crops.
2. Production techniques of various horticultural crops.
3. Establishment of orchard and its management

Course Outcomes:

On completion of this course, students will be able to

1. Explain the significance and scope of horticultural crops
2. Identify and describe the growth and development of various horticultural crops
3. Discuss the production of horticultural crops in the country and related imports and exports
4. Understand the production techniques of horticultural crops
5. Plan the establishment of orchard and its management
6. Explain special horticultural operations and organic farming in horticultural crops

18AG1007 - IRRIGATION WATER MANAGEMENT

Credits: 1:0:1

Course objectives:

To impart knowledge on

1. Water resources of the country and states
2. Soil - water - plant relationships and soil moisture constant
3. Concept of water requirement of crops and irrigation management

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concepts of irrigation and the indices used for irrigation management
2. Describe irrigation scheduling and water requirement for major agricultural crops
3. Discuss implementation of surface, sub surface, pressurized and micro irrigation systems
4. Explain water use efficiency of major crops of Tamil Nadu
5. Apply the concepts of water productivity and principles of drainage for better crop production
6. Analyse irrigation water quality and water management of major crops of Tamil Nadu

18AG1008 - PRINCIPLES OF GENETICS AND CYTOGENETICS

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. The fundamentals of mendelian inheritance and gene interactions
2. The concept of linkage and its determination, chromosomal aberrations and ways to induce it.
3. Cytoplasmic inheritance and its applications, genetic makeup of cell and the process and regulation of gene synthesis

Course Outcomes:

On completion of this course, students will be able to

1. Solve problems in Mendelian genetics
2. Construct gene map using linkage
3. Identify the type of aberrations and its usage in agriculture
4. Understand the process of inducing mutation by artificial methods
5. Explain the central dogma of life
6. Discuss Cytoplasmic inheritance in breeding

18AG1009 - FUNDAMENTALS OF CROP PHYSIOLOGY

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Concept of water relations in plants
2. Physiological processes and its effects on plant growth
3. Role of plant growth regulators and its application in crop growth

Course Outcomes:

On completion of this course, students will be able to

1. Understand the physiology of plant tissues and cells
2. Remember water movement in plant systems like diffusion and osmosis
3. Apply the concept of water relations, mineral uptake in the field of agriculture
4. Summarize the various physiological processes
5. Measure and analyse the physiological parameters of crops
6. Recommend use of growth regulators to solve physiological problems

18AG1010 - FUNDAMENTALS OF PLANT PATHOLOGY

Credits: 3:0:1

Course Objectives:

To impart knowledge on

1. Plant diseases and plant pathogens
2. Classification and life cycle of plant pathogens
3. Basics of plant disease management

Course Outcomes:

On completion of this course, students will be able to

1. Remember the factors responsible for disease development
2. Understand the importance of different plant pathogens with their characteristics and classification
3. Recall the reproduction, survival and transmission of plant pathogens
4. Explain the mode of dispersal, role of enzymes and toxins in disease development
5. Analyse defense mechanism in plants and their epidemiological factors
6. Apply knowledge on management of plant diseases

18AG1012 - FUNDAMENTALS OF AGRICULTURAL ECONOMICS

Credits: 2:0:0

Course objectives:

To impart knowledge on

1. Principles of economics and introduction to macro and micro economics
2. Basic theories of economics, concepts of agricultural economics and its relation to other subjects
3. Different credit and tax systems in agriculture.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the principle and theories, and its role in planning for economic development of the country
2. Remember consumer behaviour - utility maximization problem and demand theory
3. Explain fundamental concepts of agricultural economics, theory of production, theory of cost and output determination across market structures
4. Evaluate different agricultural finance systems and their role as credit agencies
5. Enumerate and discuss different taxes applicable to agriculture
6. Analyse theory of general equilibrium and welfare economics

18AG1013 - FUNDAMENTALS OF SOIL SCIENCE

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Soil forming process and physical properties of soil.
2. Soil chemical properties and reactions.
3. The impacts of soil pollution and the remediation measures.

Course Outcomes:

On completion of this course, students will be able to

1. Understand the genesis, pedological and edaphological concepts of soil
2. Remember different systems of soil classification
3. Evaluate the soil chemical properties and use them for soil reclamation.
4. Explain the physical properties of Soil
5. Apply the knowledge for selection of crops and Irrigation systems
6. Analyse the soil pollutant factors and recommending suitable remedial measures for soil improvement

18AG1014 - FUNDAMENTALS OF AGRICULTURAL EXTENSION EDUCATION

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. The concept of extension education and its importance in Agriculture development
2. Various rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis
3. The new innovations of agricultural extension activities in India

Course Outcomes:

On completion of this course, students will be able to

1. Understand agricultural extension and rural development programs
2. Create employment opportunity based on the knowledge gained on different schemes operated by state and central governments
3. Remember the new innovations in the area of agricultural extension in India
4. Apply the practical knowledge gained on technology transfer from lab to land.
5. Create awareness among farmers on different communication technology and journals available for scientific farming
6. Apply the knowledge for uplifting poor and marginal farmers

18AG1016 - INTRODUCTORY AGRO FORESTRY

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. The importance of forest and agroforestry systems in sustaining the land productivity
2. Crop tree interactions in different types of agroforestry systems
3. Productive and protective functions of agroforestry

Course Outcomes:

On completion of this course, students will be able to

1. Understand the forest eco system and forest regeneration.
2. Remember the concepts of agroforestry practiced in various agro ecosystems
3. Apply the knowledge for developing agro forestry, wind breaks, shelter belts, silviculture and social forestry.
4. Recall the multipurpose trees in agroforestry systems
5. Analyse the impact of nitrogen fixation, carbon sequestration and develop strategies for climate mitigation.
6. Explain the beneficial effects of agro forestry in relation to nitrogen fixation, soil conservation, litter dynamics and nutrient cycles

18AG2001 - PRINCIPLES OF PLANT BREEDING

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Genetic diversity, inheritance and variation in crops
2. Different breeding methods in autogamous, allogamous and asexually propagated crops
3. Intellectual Property Rights, patenting, Plant Breeders and Farmers Rights

Course Outcomes:

On completion of this course, students will be able to

1. Understand the basic concepts of plant breeding and genetics
2. Remember origin and diversity of different crops, components of inheritance and variations
3. Apply the knowledge to develop high yielding crops with improved quality
4. Produce varieties and hybrids with Host Plant resistance
5. Apply the protocols of Intellectual Property Rights and Patenting in release of new variety/hybrid
6. Analyse Plant Breeders and & Farmer's Rights for research and commercial seed production of high yielding crops

18AG1011- FUNDAMENTALS OF ENTOMOLOGY

Credits: 3:0:1

Course objectives:

To impart knowledge on

1. Insect morphology, anatomy and physiology
2. Insect ecology, classification of pesticides and concept of different pest management techniques
3. Study of insects systematics

Course Outcomes:

On completion of this course, students will be able to

1. Understand the insect external body parts and their modifications
2. Acquire knowledge on structure of various organ systems and their functions
3. Analyse the factors influencing pest occurrence
4. Understand the concept of different pest management techniques
5. Develop knowledge on different orders and families of agriculturally important pests
6. Analyse the pest management strategies

18AG2002 - CROP PRODUCTION TECHNOLOGY - I (KHARIF CROPS)

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. Fundamental understanding of kharif season
2. Economic importance of kharif crops
3. Cultural practices of kharif crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the crop production technology for kharif crops
2. Explain the geographical distribution of kharif crops
3. Recall crop production requirements for kharif season crops
4. Remember soil and climatic requirements of different kharif crop varieties
5. Describe crop management practices for kharif season
6. Apply the acquired knowledge to guide the farmers for cultivating kharif crops

18AG2003 - AGRICULTURAL FINANCE AND COOPERATION

Credits: 2:0:1

Course objectives:

To impart knowledge on

1. Agricultural Finance and Indian financial institutions purveying agricultural credit in India.
2. Structure, functions and services of commercial banks and non-banking financial institutions in India
3. Historic and contemporary role of cooperatives and their contribution to the farming community

Course Outcomes:

On completion of this course, students will be able to

1. Explain the financial system in India
2. Apply principles of banking and credit appraisal procedure
3. Analyse credit and deposit services of private, public and cooperative sector banks
4. Prepare and analyse Balance Sheet and Income and Expenditure Statements of a business unit
5. Develop skills in credit analysis, dealing with bankers, loan application procedures
6. Popularize farmer-friendly schemes of Crop insurance and Cooperative warehousing among farmers

18AG2004 - PRODUCTION TECHNOLOGY OF VEGETABLES

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. Importance of vegetable cultivation and prominent vegetables in India
2. Production technology of tropical vegetable crops
3. Plant protection measures in vegetable crops

Course Outcomes:

On completion of this course, students will be able to

1. Appreciate the role of vegetables in human nutrition and national economy
2. Follow scientific agronomic practices in producing tropical vegetable crops
3. Control pest, diseases, weed and physiological disorders in tropical vegetable crops
4. Create and maintain kitchen gardens
5. Understand the harvesting methods of vegetable crops
6. Apply post-harvest technology in processing of vegetables

18AG2007 - FARMING SYSTEMS AND SUSTAINABLE AGRICULTURE

Credits: 1:0:0

Course Objectives:

To impart knowledge on

1. Sustainable agriculture
2. Scope and efficiency maximization through integrated farming systems
3. Different farming systems and its interaction in farm productivity

Course Outcomes:

On completion of this course, students will be able to

1. Understand Sustainability of Agriculture and its importance
2. Differentiate the types of farming and cropping systems
3. Relate sustainable agriculture and conventional agriculture
4. Analyse indicators of sustainability, adaptation, mitigation and conservation
5. Apply site-specific integrated farming systems for sustainability
6. Use farm resources efficiently

18AG2015 - ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The natural resources- Renewable and Non renewable
2. The ecosystem, biodiversity, environmental pollution and conservation aspects
3. The Natural and Man- made Disasters and their Management

Course Outcomes:

On completion of this course, students will be able to

1. Identify and distinguish the natural resources- Renewable and Non renewable
2. Illustrate the concepts of ecosystem and biodiversity
3. Examine and solve environmental pollution issues
4. Plan the conservation strategies
5. Understand Environmental laws and legislation
6. Enumerate the disaster management strategies

18AG2029 - PRINCIPLES OF ORGANIC FARMING

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. Historical, physio-chemical, biological and ecological basis of organic farming including various crop and soil management practices
2. Agronomic practices and farming techniques of different crops and cropping systems under organic farming
3. Concepts related to legislation, inspection, certification, and marketing of organic produce

Course Outcomes:

On completion of this course, students will be able to

1. Remember the concepts of organic farming
2. Understand the crop management practices and technologies of various crops
3. Recall the different cropping systems of Tamil Nadu
4. Compare the organic crop production with inorganic crop production
5. Apply the knowledge of standards and certification process of organic produce
6. Analyse different marketing strategies of organic farm products

18AG2005 - LIVESTOCK AND POULTRY MANAGEMENT

Credits: 3:0:1

Course objectives:

To impart knowledge on

1. Importance of farm animals and characters of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry
2. Improvement of farm animal and poultry disease control
3. Management of farm animals and housing requirement

Course Outcomes:

On completion of this course, students will be able to

1. Know the importance of farm animals and its influence in rural economy
2. Distinguish characteristics of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry
3. Select quality breeds and poultry and improve livestock in a farm
4. Choose nutritious feed rations and feed animals and poultry
5. Set up proper housing for farm animal and poultry
6. Manage farm animal diseases, young ones and their products – milk, meat and egg.

18AG2008 - CROP PRODUCTION TECHNOLOGY-II (RABI CROPS)

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Economic importance of Rabi crops
2. Management of Rabi crop production
3. Cultural practices of Rabi crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the economic importance of Rabi crops
2. Know the agro-ecological requirements for Rabi crop production
3. Apply cultural practices for wheat and barley
4. Apply cultural practices for oilseeds and pulses
5. Apply cultural practices of sugarcane and medicinal crops
6. Be aware of the innovations and research advancements in Rabi crop production

18AG2009 - PRODUCTION TECHNOLOGY FOR ORNAMENTAL CROPS AND LANDSCAPING

Credits: 1:0:1

Course Objectives:

To impart knowledge on

4. Production technology of cut flowers, ornamental crops and turf management
5. Landscape use of trees, shrubs and climbers
6. Styles of landscape gardening and post –harvest handling of flower crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand production technology of cut flowers and ornamental crops
2. Establish lawns and manage turf grass
3. Apply principles of landscaping using trees, shrubs and climbers
4. Design different styles of gardens
5. Handle flower crop production, harvesting and post-harvest operations
6. Perform training and pruning of ornamental plants

18AG2010 - PRODUCTION TECHNOLOGY OF FRUITS AND PLANTATION CROPS

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Economic importance of fruit and plantation crops in India
2. Production technology and cultivation methods of fruit and plantation crops
3. Propagation methods in fruit and plantation crops

Course Outcomes:

On completion of this course, students will be able to

1. Understand the scope and importance of fruit and plantation crop production
2. Apply propagation methods in fruit and plantation crops
3. Apply production technologies in fruit and plantation crops
4. Manage pests of fruit and plantation crops
5. Control diseases of fruits and plantation crops
6. Handle physiological disorders of fruit and plantation crops

18AG2011 - PRINCIPLES OF SEED TECHNOLOGY

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Importance of seed and concepts of seed, its classification, certification, purity and Seed Act
2. Foundation and certified seed production protocols and procedures of cereals, pulses, oilseeds, fodder and vegetable crops
3. Seed storage, pest and disease control, seed distribution infrastructure and protocols in India

Course Outcomes:

On completion of this course, students will be able to

1. Know seed concepts and importance of seed in agricultural production
2. Distinguish types of seeds and know seed certification process
3. Apply seed production techniques in cereals, pulses, and oilseeds, vegetable and forage seeds
4. Describe seed structure and morphology, physical characteristics of seed
5. Conduct varietal identification, seed quality assessments tests and seed treatments
6. Develop skills in seed storage and seed marketing

18AG2012 - PROBLEMATIC SOILS AND THEIR MANAGEMENT

Credits: 2:0:0

Course Objectives:

To impart knowledge on

1. Soil health and irrigation water quality parameters
2. Reclamation and management of problem soils
3. Remote sensing, GIS, land use pattern and soil classification

Course Outcomes:

On completion of this course, students will be able to

1. Understand soil quality and their categories
2. Distinguish problematic soils
3. Describe irrigation water quality standards
4. Apply soil reclamation practices for saline, sodic and acid soils
5. Understand remote sensing, GIS and bioremediation procedures
6. Identify land use patterns.

18AG2013 - AGRICULTURAL MARKETING, TRADE AND PRICES

Credits: 2:0:1

Course objectives:

To impart knowledge on

1. Market structure and its classification
2. The theories of demand and supply of agricultural produce in market oriented economy
3. The grading, packing, branding, labelling (AGMARK) of agricultural produce

Course Outcomes:

On completion of this course, students will be able to

1. Know the contours of agricultural market ecosystem, different market structures and their functions
2. Analyse the demand and supply problems in agricultural marketing systems, marketing efficiency and policies
3. Demonstrate the methods of valuation of farm assets
4. Understand the food supply chain and its actors and activities
5. Gain practical skills in dealing with marketing institutions and warehouses
6. Understand international trade arrangements under WTO, Agreement on Agriculture (AOA) and EXIM policies.

18AG2014 - INTRODUCTION TO BIOTECHNOLOGY

Credits: 2:0:1

Course objectives:

To impart knowledge on

1. The basic scientific evidence and technical aspects of the different disciplines of biotechnology in agriculture (mainly for plants and crops).
2. The concepts and techniques in biotechnology
3. The foundations of modern biotechnology and the principles that form the basis for recombinant DNA technology

Course Outcomes:

On completion of this course, students will be able to

1. Understand the structure and function of prokaryotic and eukaryotic cells.
2. Distinguish the gene transcription, translation and mutations
3. Experiment with the concepts of gene regulation and gene expression
4. Make use of genetic engineering for vaccines, transgenic plants, animal cell culture, and hybridoma technology.
5. Utilize molecular and immunological techniques
6. Apply biosensors for bioremediation, bioprocess engineering and bioprospecting.

18AG2016 - MEDICINAL, SPICES AND AROMATIC PLANTS

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. The scope and importance of medicinal, spices and aromatic plants
2. The production technology of medicinal, spices and aromatic plants
3. The various processes, essential oils and their uses of medicinal, spices and aromatic plants

Course Outcomes:

On completion of this course, students will be able to

1. Infer the scope and importance of medicinal, spices and aromatic plants
2. Apply the production technology of medicinal, spices and aromatic plants
3. Develop storage facilities of essential oils and spices
4. Experiment with the integrated nutrient management and plant protection of medicinal, spices

- and aromatic plants
- 5. Analyse the constraints in production technology of important medicinal plants
- 6. Discover new processing and value addition of MAP

18AG2017 - STUDY TOUR – I

Credits: 0:0:1

Course Objectives:

To impart knowledge on

1. Functioning of agricultural research institutions throughout the state
2. On-going agricultural research and extension programs
3. Region specific crop production technologies

Course Outcomes:

On completion of this course, students will be able to

1. Categorize agricultural crops grown in the different agro climatic zones of Tamil Nadu
2. Remember different agro-climatic zones of Tamil Nadu
3. Distinguish social, cultural and economic differences in various agricultural zones
4. Compare and contrast the different soil types and cropping systems in Tamil Nadu
5. Recommend climate and region specific cultivation practices
6. Analyse different rainfall patterns of different agro-climatic zones of Tamil Nadu

18AT2042 - RENEWABLE ENERGY AND GREEN TECHNOLOGY

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. Concept of renewable energy.
2. The various green technology techniques.
3. Technical know-how on renewable energy measures.

Course Outcomes:

On completion of this course, students will be able to

1. Gain basic knowledge of Solar energy harvesting
2. Familiarize with different types of Solar energy gadgets
3. Understand the contributions of energy sources to agriculture
4. Remember different types of biogas production structures
5. Design renewable energy structures
6. Analyse the green energy techniques

18AG2018 - PRACTICAL CROP PRODUCTION-I (KHARIF CROPS)

Credits 0:0:2

Course Objectives:

To impart knowledge on

1. Practical cultivation practices of Kharif crops
2. The phenological phases and its significance of each phase in production of Kharif crops
3. Calculation and estimation of yield and other parameters influencing yield of Kharif crops

Course Outcomes:

On completion of this course, students will be able to

1. Cultivate *Kharif* crops
2. Describe the significance of different phenological stages
3. Identify problems in *Kharif* cultivation and to offer solutions
4. Suggest marketing channels for products of *Kharif* crop cultivation
5. Make use of modern farm equipment
6. Construct a balance sheet showing cost of cultivation and net income generated

18AG2019 - CROP IMPROVEMENT – I (kharif)

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. Diversity, inheritance and genetic variations present in kharif crops
2. The breeding methods in asexually propagated, self and cross pollinated kharif crops
3. Hybrid seed production techniques and ideotype concepts in kharif crops

Course Outcomes:

On completion of this course, students will be able to

1. Remember the origin and diversity of different crops, components of inheritance and various crop improvement techniques
2. Understand the genetics of qualitative and quantitative characters
3. Remember different breeding procedures for genetic improvement of kharif crops
4. Evaluate the adaptability, stability, quality parameters, biotic and abiotic stress of various kharif crops
5. Utilize hybrid seed production techniques in cultivation of kharif crops
6. Design and conduct field experiments to analyse the quality characters of donor parents

18AG2020 - MANURES, FERTILIZERS AND SOIL FERTILITY MANAGEMENT

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Properties and composition of organic manures and chemical fertilizers
2. Mechanism of nutrient transport in plant and soil, plant nutrient deficiency and toxicity symptoms
3. Soil chemistry, soil fertility testing and plant nutrient analysis

Course Outcomes:

On completion of this course, students will be able to

1. Understand the properties of manures, fertilizers and soil amendments
2. Summarize the concepts of soil fertility, plant nutrition and chemistry of nutrients in soil.
3. Remember the mechanism of nutrient transport and develop Integrated Nutrient Management (INM) practices
4. Evaluate the fertility of soil
5. Analyse the plant nutrient content
6. Recommend fertilizer dosage for different soil types

18AG2021 - DISEASES OF FIELD AND HORTICULTURAL CROPS AND THEIR MANAGEMENT - I

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Major diseases of field and horticultural crops and their causal organisms
2. The symptoms associated with the disease and their etiology and disease cycle
3. The integrated practices to be followed for the management of plant pathogens

Course Outcomes:

On completion of this course, students will be able to

1. Summon up various plant diseases and their causal organisms in major field and horticultural crops
2. Identify the sign and symptoms for detection and diagnosis of plant diseases
3. Determine the prevalence, epidemiology and factors affecting disease development
4. Comprehend the disease cycle of various plant diseases
5. Analyse the host pathogen interaction on disease development
6. Apply integrated management practices to control the diseases of field and horticultural crops

18AG2022 - PRINCIPLES OF INTEGRATED PEST AND DISEASE MANAGEMENT

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. The various categories of economically important pest and diseases
2. The principles and methods of detection and diagnosis of pest and diseases
3. Integrated pest and disease management practices

Course Outcomes:

On completion of this course, students will be able to

1. Relate and recall the important concepts and principles of Integrated pest and disease management practices
2. Summarize and illustrate the important pest and diseases of various crops
3. Remember damage symptoms and diagnose the pests/diseases
4. Formulate Integrated pest management (IPM) strategies
5. Recommend pest and disease management practices to farmers
6. Monitor and predict pest and disease outbreak

18AG2023 - PESTS OF CROPS, STORED GRAINS AND THEIR MANAGEMENT

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Symptoms, damage and seasonal incidence of agricultural, horticultural and storage pests
2. Fundamental principles and components of Insect Pest Management
3. Importance of storage pests and management strategies to avoid losses

Course Outcomes:

On completion of this course, students will be able to

1. Remember morphology and taxonomic characteristics of insect pests affecting crops and stored grains
2. Understand nature and type of damage by different arthropod pests in field, vegetable, fruit and plantation crops, ornamental crops, spices and condiments
3. Analyse factors influencing pest occurrence, distribution and their management
4. Summarize factors affecting losses of stored grain,
5. Examine the role of various factors in deterioration of grain and their management strategies
6. Recommend pest management measures to farmers

18AG2024 - PRECISION FARMING

Credit 1:0:1

Course Objectives:

To impart knowledge on

1. Role of GIS, GPS and drones in agriculture
2. Sensors and its application in agriculture
3. Crop simulation models and their role in precision farming

Course Outcomes:

On completion of this course, students will be able to

1. Understand the concept of precision farming
2. Relate the use of GIS and GPS systems in drip installation and fertigation techniques
3. Know the operation of an Unmanned Aerial Vehicle (UAV) to gather information
4. Develop precision farming technology for important crops
5. Evaluate applications of sensors in agriculture
6. Apply crop simulation models and site specific management using GIO referencing

18AG2025 - ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT

Credit 1:0:1

Course Objectives:

To impart knowledge on

1. Characteristics of entrepreneurs and orientation towards becoming an entrepreneur
2. Agri-business opportunities that are commercially successful and the procedures involved in start-ups
3. The art and science of business plan formulating business proposals

Course Outcomes:

On completion of this course, students will be able to

1. Distinguish entrepreneurial traits and skills
2. Assess agribusiness opportunities open for agriculture graduates
3. Apply leadership skills towards obtaining financial support for start-ups
4. Understand the effect of economic reforms in agri-business
5. Perform SWOT analysis of an entity for any prospective agribusiness/ideas
6. Formulate business proposal for successful implementation of the business plan

18AG2026 - INTELLECTUAL PROPERTY RIGHTS

Credit 1:0:0

Course Objectives:

To impart knowledge on

1. Individual's rights to protect/patent inventions obtained in the process of project work
2. Strategies to register inventions/designs, in India and abroad
3. Patenting, copyright, trademark, designs and information technology act

Course Outcomes:

On completion of this course, students will be able to

1. Understand GATT, WTO, TRIPs and WIPO for IPR protection
2. Know to acquire the patent and copyright for their innovative work.
3. Remember plagiarism, which can be questioned legally.
4. Explain UPOV and PPV and FR Act of India
5. Apply, analyse and use ITR strategies
6. Achieve new innovative goals

18AG2006 - AGRI INFORMATICS

Credit 1:0:1

Course Objectives:

To impart knowledge on

1. Application of IT in agriculture using computerized models
2. Precision agriculture using geospatial technology
3. Decision Support Systems (DSS) and soil information for agricultural applications

Course Outcomes:

On completion of this course, students will be able to

1. Understand use of information, communication and technology (ICT) in agriculture
2. Use GIS and GPS systems in precision agriculture
3. Develop computerized models to understand plant growth process.
4. Use smart phone devices in farm advisory, farm price and postharvest management
5. Manage input requirements for crops and animals
6. Use agriculture expert system and soil information systems for farm decisions

18AG2027 - RAINFED AGRICULTURE AND WATERSHED MANAGEMENT

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Systems of rainfed agriculture, land suitability and farming practices in rainfed regions
2. Adaptation and mitigation strategies, crop planning and crop management techniques
3. The concepts, principles and components of water conservation and management

Course Outcomes:

On completion of this course, students will be able to

1. Understand sustainable agriculture practices under rainfed conditions
2. Remember soil and climatic conditions of rainfed areas
3. Explain the various crop management techniques and the adaptation strategies for dry land agriculture
4. Formulate contingent water planning for aberrant weather conditions
5. Apply knowledge of different water conservation methods and effective water utilization through use of watershed management
6. Simulate artificial hydrologic watersheds for effective watershed maintenance

18AG2028 - PRACTICAL CROP PRODUCTION-II (RABI CROPS)

Credits 0:0:2

Course Objectives

To impart knowledge on

1. Practical training on cultivation practices of rabi crops
2. Phenological phases and significance of each phase in crop production
3. Calculating/estimating the yield and other parameters influencing crop yield

Course Outcomes

On completion of this course, students will be able to

1. Gain knowledge about cultivation practices of Rabi crops
2. Identify problems relating to Rabi crop production and offer solutions
3. Recommend package of practices for Rabi crops
4. Suggest marketing channels for products of cultivation
5. Make use of modern farm equipment
6. Construct a balance sheet with inputs of cultivation costs and net income generated

**18AG2030 - DISEASES OF FIELD & HORTICULTURAL CROPS
AND THEIR MANAGEMENT - II**

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. Major diseases of field and horticultural crops
2. Causal organisms of plant diseases, etiology and disease cycle
3. Integrated farming practices to be followed for effective management of plant pathogens

Course Outcomes

On completion of this course, students will be able to

1. Recall various plant pathological terms and basic concepts of important plant diseases
2. Explain the disease symptoms of various plant diseases of field and horticultural crops
3. Examine the host pathogen interaction on disease development in field and horticultural crops
4. Determine the prevalence, epidemiology and factors affecting disease development
5. Apply the concept of integrated management practices to control the diseases of field and horticultural crops
6. Recommend disease management practices to farmers

**18AG2031 - POST HARVEST MANAGEMENT AND VALUE ADDITION OF
FRUITS AND VEGETABLES**

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. Extent of postharvest losses of fruits and vegetables and scope of food processing and

- preservation
- 2. Different preservation techniques and value addition process of important fruits and vegetables
- 3. Government schemes and laws regulating import and export of fresh fruits and vegetables

Course Outcomes:**On completion of this course, students will be able to**

- 1. Remember the different post-harvest management of important fruits and vegetables
- 2. Understand the factors causing postharvest losses in fruits and vegetables
- 3. Identify principles and methods of preserving fruits and vegetables
- 4. Explain about the different value addition process of important fruits and vegetables
- 5. Examine the process of food spoilage and quality control of processed foods
- 6. Demonstrate knowledge about the different government schemes and laws in import and export

18AG2032 - CROP IMPROVEMENT – II (Rabi)**Credits: 1:0:1****Course Objectives:**

To impart knowledge on

- 1. Genetic diversity and center of origin for different Rabi crops
- 2. Different breeding methods in asexually propagated, self and cross pollinated Rabi crops
- 3. Hybrid seed production techniques and ideotype concepts in rabi crops

Course Outcomes:

On completion of this course, students will be able to

- 1. Remember the origin and diversity of different crops, components of inheritance and various crop improvement techniques
- 2. Understand different breeding techniques for the genetic improvement of Rabi crops
- 3. Evaluate the adaptability, stability, quality parameters, biotic and abiotic stress of various Rabi crops
- 4. Make use of hybrid seed production techniques in farming of Rabi crops.
- 5. Examine hybrid seed production methods
- 6. Apply knowledge to develop climate resilient crop varieties

18AG2033 - MANAGEMENT OF BENEFICIAL INSECTS**Credits: 1:0:1****Course Objectives:**

To impart knowledge on

- 1. The importance of beneficial insects and their uses
- 2. Mulberry cultivation and silkworm rearing using innovative techniques
- 3. Bee keeping techniques and mass culturing of predators and parasitoids

Course Outcomes:

On completion of this course, students will be able to

- 1. Explain the importance of beneficial insects
- 2. Describe the morphology, biology and behaviour of beneficial insects
- 3. Identify the common parasitoids and predators used in biological control
- 4. Mass multiply the natural enemies
- 5. Rear silkworms using innovative techniques
- 6. Practice beekeeping for commercial purpose

18AG2034 - FARM MANAGEMENT, PRODUCTION & RESOURCE ECONOMICS**Credits: 1:0:1****Course Objectives:**

To impart knowledge on

- 1. Concepts and principles of farm management and production economics

2. Economic principles/theory underlying resource allocation and decision- making process
3. Application of economic principles in organizing and managing businesses with special emphasis on optimal enterprise combinations to meet household goals

Course Outcomes:

On completion of this course, students will be able to

1. Know the concepts and principles of farm management and production economics
2. Optimize use of capital, labour and land by recalling when, where and how to produce
3. Discuss management of resources in crop production process, livestock and allied enterprises.
4. Apply economic principles in farm management
5. Plan optimal enterprise combinations to meet household goals
6. Analyse farm business, collect and analyse data on various resources

18AG2035 - PRINCIPLES OF FOOD SCIENCE AND NUTRITION**Credit 2:0:0****Course Objectives**

To impart knowledge on

1. The basic concepts of food science, food chemistry and food microbiology
2. The principles and methods of food processing and microbial food spoilers
3. Malnutrition, nutritional disorders and planning a balanced/modified diet

Course Outcomes:

On completion of this course, students will be able to

1. Explain the concepts of food science
2. Enumerate and describe food composition and food chemistry
3. Understand the principles and methods of food processing
4. Analyse the methods to control microbes and preserve food
5. Identify the nutritional disorders
6. Design balanced/modified diet to meet consumer needs.

18AG2036 - STUDY TOUR – II**Credits: 0:0:1****Course Objectives:**

To impart knowledge on

1. The various crops and cropping systems of South India
2. The various agricultural and agro-based institutions/ Research Stations/ Colleges in South India
3. The ongoing agricultural research and extension programmes implemented by the Government and the State Agricultural Universities

Course Outcomes:

On completion of this course, students will be able to

1. Identify the various crops across the states of South India
2. Discuss the cropping systems practiced in the different agro-climatic zones of South India
3. Describe the soils, irrigation practices, sources of irrigation and other farming related activities in different parts of their visit
4. Assess the scope of farming, agro-based industries and related activities across the states of South India.
5. Relate the social and cultural aspects of the people of different agricultural zones
6. Discuss the commercial operations of farming and related activities

18AG2037 - SPICES, MEDICINAL AND AROMATIC CROPS**Credits: 2:0:1****Course Objectives**

To impart knowledge on

1. The scope and importance of Spices, medicinal and aromatic crops
2. Production technology of Spices, medicinal and aromatic plants
3. Processing techniques, essential oil extraction and its uses

Course Outcomes:

On completion of this course, students will be able to

1. Explain the opportunities and constraints in the cultivation of spices, medicinal and aromatic crops.
2. Describe the morphology and demonstrate the production techniques of these crops
3. Illustrate the organic production of spices, medicinal and aromatic crops
4. Identify and recommend the suitable postharvest techniques for the crops
5. Understand the processing techniques and essential oil extraction procedures
6. Describe the uses of Spices, medicinal and aromatic plants and their products

18AG2038 - PRECISION FARMING AND AGRO INFORMATICS**Credit 2:0:1****Course Objectives:**

To impart knowledge on

1. The importance and concepts of precision farming and Hi-tech precision farming.
2. The techniques employed in precision farming
3. The applications of Agro informatics and information, communication and technology (ICT) in agriculture

Course Outcomes:

On completion of this course, students will be able to

1. Explain the concepts and tools used in precision farming
2. Apply the precision farming technology to various crops
3. Express proficiency on database creation, data analysis and processing
4. Develop mobile mapping system and its application in decision support systems of precision farming
5. Design the layout and installation of drip lines for fertigation
6. Apply the information, communication and technology (ICT) in agriculture

S.No	Code	Course name	Credits
1	17HO1002	Propagation of horticultural crops	1:0:1
2	17HO1003	Production technology of Tropical and Arid zone fruit crops	2:0:1
3	17HO1004	Production technology of Tropical vegetable crops	2:0:1
4	18HO1001	Fundamentals of Horticulture	2:0:1
5	18HO1002	Growth and Development of Horticultural Crops	2:0:1
6	18HO1003	Propagation and Nursery Management for Horticultural Crops	2:0:1
7	18HO1004	Production Technology of Tropical and Subtropical Fruits	2:0:1
8	18HO1005	Production Technology of Tropical and Subtropical Vegetables	2:0:1
9	18HO1006	Irrigation and Weed Management in Horticultural Crops	2:0:1
10	18HO2001	Commercial floriculture	2:0:1
11	18HO2002	Production Technology of Spices and Plantation Crops	2:0:1
12	18HO2003	Precision Farming and Protected Cultivation	2:0:1
13	18HO2004	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	2:0:1
14	18HO2005	Soil Fertility and Nutrient Management	1:0:1
15	18HO2006	Production Technology of Temperate Vegetable Crops	1:0:1
16	18HO2007	Production Technology of Temperate Fruit Crops	1:0:1
17	18HO2008	Production Technology of Medicinal and Aromatic Crops	2:0:1
18	18HO2009	Breeding of Vegetables, Medicinal and Aromatic Crops	3:0:1
19	18HO2010	Diseases of Vegetables, Flowers, Ornamentals and Spice Crops	2:0:1
20	18HO2012	Study tour – I	0:0:1
21	18HO2013	Principles of Ornamental Horticulture and Landscape Architecture	2:0:1
22	18HO2014	Dryland horticulture	2:0:1
23	18HO2015	Breeding of Fruits and Plantation Crops	2:0:1
24	18HO2016	Seed Production of Vegetable, Tuber and Spice Crops	2:0:1
25	18HO2017	Insect Pests of Vegetable, Ornamental and Spice Crops	2:0:1
26	18HO2018	Introduction to Major Field Crops	1:0:1
27	18HO2019	Economics and Marketing	2:0:1
28	18HO2011	Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops	2:0:1
29	18HO2020	Horti-business management	2:0:0
30	18HO2021	Post-harvest Management and Processing of Horticultural Crops	2:0:2
31	18HO2022	Breeding and Seed Production of Flower and Ornamental Plants	2:0:1
32	18HO2023	Nematode Pests of Horticultural Crops and their Management	1:0:1
33	18HO2024	Apiculture, Sericulture and Lac Culture	1:0:1
34	18HO2025	Study tour - II	0:0:1

17HO1002 - PROPAGATION OF HORTICULTURAL CROPS

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. Different methods of propagation
2. Micro propagation techniques
3. Post propagation techniques

Course Outcomes:

At the end of this course, students will be able to

1. Remember different propagation techniques of horticultural plants on the basis of their pollination
2. Understand the basics underlying in choosing the right propagation technique
3. Describe different Media preparation techniques of Micropropagation
4. Elaborate the procedure for mother plant selection
5. Produce their own cultivars
6. Start commercial Micropropagation companies

17HO1003 - PRODUCTION TECHNOLOGY OF TROPICAL AND ARID ZONE FRUIT CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The scope and production details of Tropical and Subtropical Fruit crops in India
2. The physiology, characteristics and production techniques of these fruit crops.
3. The post-harvest management techniques involved in the preservation and processing of Tropical and Subtropical fruit crops

Course Outcomes

At the end of this course, the students will be able to

1. Explain the botanical description and classification of Tropical and Subtropical fruit crops
2. Identify the various Tropical and Subtropical fruit crops
3. Describe the specific production technology and cultural practices for each of these fruit crops
4. Discuss the modern production techniques involved in the production of Tropical and Subtropical fruit crops
5. Explain fruit setting and production constraints encountered there within
6. Practice harvesting and post-harvest handling of Tropical and Subtropical Fruits

17HO1004 - PRODUCTION TECHNOLOGY OF TROPICAL VEGETABLE CROPS

Credits: 2:0:1

Course Objectives:

To impart knowledge/ skill on

1. Recent import and export potential of Vegetables in India
2. Recent methods and varieties of vegetables
3. Advanced cultivation practices

Course Outcomes:

At the end of this course, the students will be able to

1. Identify the area, production and productivity of tropical and subtropical vegetables.
2. Apply the nutritional importance of vegetables.
3. Describe the input requirements for raising tropical and subtropical vegetables
4. Demonstrate the package of practices of commercially important tropical and subtropical vegetables
5. Capable to grow and maintain vegetable nursery
6. Understand the vegetables based cropping systems and post-harvest handling of vegetables

18HO1001 - FUNDAMENTALS OF HORTICULTURE

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The scope and importance of horticultural crops.
2. The production techniques of various horticultural crops.
3. Establishment of orchard and its management.

Course Outcomes:

On completion of this course, the students will be able to

1. Explain the significance and scope of horticultural crops

2. Identify and describe the growth and development of various horticultural crops
3. Discuss the production of horticultural crops in the country and related imports and exports
4. Demonstrate the production techniques of horticultural crops
5. Plan the establishment of Orchard and its management
6. Practice Special horticultural operations and organic farming in these crops.

18HO1002 - GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The growth and developmental functions of horticultural crops
2. Plant bio-regulators and their functions
3. Physiology of fruit growth and development

Course outcomes:

On completion of this course, the students will be able to

1. Explain the functions related to growth and development of horticultural crops
2. Discuss the application of Plant bio-regulators for specific functions of the plant
3. Describe the process of fruit setting and related physiology
4. Prepare hormonal solutions that influences various functions of the crop
5. Identify the physiological disorders and suggest remedial measures
6. Describe the physiology of fruits under post-harvest storage

18HO1003 - PROPAGATION AND NURSERY MANAGEMENT FOR HORTICULTURAL CROPS

Credits 2:0:1

Course Objectives

To impart knowledge on

1. The tools and principles involved in propagation of horticultural crops
2. The use of propagation structures and plant materials used in the multiplication of horticultural crops
3. Scope and techniques of micro-propagation in horticultural crops

Course Outcomes:

On completion of this course, the students will be able to

1. Demonstrate the propagation and nursery management techniques for horticultural crops
2. Describe the various structures used for propagation
3. Select the mother plant and prepare the propagation plant materials
4. Practice handling of tools used in propagation and achieve skill oriented knowledge
5. Plan appropriate management of nursery and young propagated plants
6. Outline the micro-propagation techniques for horticultural crops

18HO1004 - PRODUCTION TECHNOLOGY OF TROPICAL AND SUBTROPICAL FRUITS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The scope and production details of Tropical and Subtropical fruit crops in India
2. The physiology, characteristics and production techniques of these fruit crops.
3. The post-harvest management techniques involved in the preservation and processing of Tropical and Subtropical fruit crops

Course Outcomes

At the end of this course, the students will be able to

1. Explain the botanical description and classification of Tropical and Subtropical fruit crops
2. Identify the various Tropical and Subtropical fruit crops
3. Describe the specific production technology and cultural practices for each of these fruit crops

4. Discuss the modern production techniques involved in the production of Tropical and Subtropical Fruit crops
5. Explain fruit setting and production constraints encountered there within
6. Practice harvesting and post-harvest handling of Tropical and Subtropical Fruits

18HO1005 - PRODUCTION TECHNOLOGY OF TROPICAL AND SUBTROPICAL VEGETABLES

Credits 2:0:1

Course Objectives:

To impart knowledge/ skill on

1. Recent import and export potential of Vegetables in India
2. Recent methods and varieties of vegetables
3. Advanced cultivation practices

Course Outcomes:

At the end of this course, students will demonstrate their ability to

1. Identify the area, production and productivity of tropical and subtropical vegetables.
2. Apply the nutritional importance of vegetables.
3. Describe the input requirements for raising tropical and subtropical vegetables
4. Demonstrate the package of practices of commercially important tropical and subtropical vegetables
5. Capable to grow and maintain vegetable nursery
6. Understand the vegetables based cropping systems and post harvest handling of vegetables

18HO1006 - IRRIGATION AND WEED MANAGEMENT IN HORTICULTURAL CROPS

Credits 2:0:1

Course objectives

To impart knowledge / skill on

1. Soil, water and plant relationships and soil moisture constant with special reference to horticultural plants
2. The concepts of water requirement of horticultural crops and its irrigation management
3. The importance of weeds its classification and management with reference to horticultural plants

Course outcomes:

At the end of this course, students will demonstrate the ability

1. Identify the different types of water resources of India available for growing horticultural crops
2. Capable to develop water budget to match the demand of raising horticultural crops
3. Able to use different types of instruments to measure the water availability in soil
4. Identify different types of weeds affect horticultural plant growth
5. Demonstrate different weed control methods
6. Capable to analyse the economics of weed control in horticultural crops

18HO2001 - COMMERCIAL FLORICULTURE

Credits 2:0:1

Course objectives

To impart knowledge on

1. Commercial flower crops and their market thrust.
2. Production technology of loose and cut flowers.
3. Harvesting and post-harvest handling of loose and cut flowers, concrete and other floral extraction methods.

Course outcomes:

At the end of this course, students will demonstrate the ability

1. Identify the opportunities and constraints of floriculture industry in India

2. Demonstrate the packages of practices of commercial flowers under different agro climatic conditions
3. Describe the technology of hi-tech cultivation of cut flowers
4. Recognize the importance and methods of post harvest operation to enhance shelf life of flowers
5. Familiar with different type of pruning in roses and other cut flowers
6. Exhibit different pattern of flower arrangements

18HO2002 - PRODUCTION TECHNOLOGY OF SPICES AND PLANTATION CROPS

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Scope and importance of spices and plantation crops
2. Production technology of spices and plantation crops
3. The Post-Harvest handling of spices and plantation crops

Course Outcomes:

At the end of this course, students will be able to

1. Analyse the scope and importance of spices and plantation crops in India
2. Demonstrate the scientific method of raising various spice and plantation crops
3. Explore the economic potential of value addition in various spices and plantation crops
4. Adoption of innovative methods of spices and plantation crops based cropping system to get more income
5. Utilize the opportunities in spice and plantation industry to set up small unit
6. Identify the government initiatives for the promotion of spices and plantation crops

18HO2003 - PRECISION FARMING AND PROTECTED CULTIVATION

Credits 2:0:1

Course objectives:

To impart knowledge on

1. The protected cultivation of vegetables, fruits and flower crops
2. Hi-tech production technology of fruits, vegetables and flower crops
3. Precision farming technology for important horticultural crops

Course outcomes:

At the end of this course, students will be able to

1. Understand the need, benefits and challenges of protected cultivation of horticultural crops
2. Analyse the importance of various forms of mechanization in increasing crop productivity
3. Understand the concepts of the internet of things, sensors, GIS and AI with agriculture crops to increase the agricultural production
4. Adopt the different type of polyhouses in different crop growing regions
5. Identify the crops suitable for poly house cultivation
6. Describe the different system of crop raising based on the concept of hydroponics

18HO2004 - DISEASES OF FRUIT, PLANTATION, MEDICINAL AND AROMATIC CROPS

Credits 2:0:1

Course objectives:

To impart knowledge

1. Etiology, damage symptoms, mode of spread and survival of plant diseases
2. Host parasite relationship of important plant diseases
3. Integrated management of important plant diseases

Course outcomes:

At the end of this course, students will be able to

1. Summon up various plant diseases and their causal organisms in major horticultural crops
2. Identify the sign and symptoms for detection and diagnosis of plant diseases

3. Determine the prevalence, epidemiology and factors affecting disease development
4. Comprehend the disease cycle of various plant diseases
5. Analyze the host pathogen interaction on disease development
6. Apply integrated management practices to control the diseases of horticultural crops

18HO2005 - SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Role of nutrients in horticultural crop production
2. Soil fertility evaluation and soil testing methods
3. The concept and management of INM

Course Outcomes:

At the end of this course, students will be able to

1. Elucidate the role of essential nutrients in various kinds of horticultural crop
2. Capable to identify the nutrient deficiency symptoms on different plants parts
3. Aware of different sources of nutrient supply to the plants
4. Demonstrate the soil testing and soil fertility evaluation
5. Analyze the importance of Bio fertilizers in crop nutrition
6. Familiar with the concept of Integrated Nutrient Management in restoring soil fertility

18HO2006 - PRODUCTION TECHNOLOGY OF TEMPERATE VEGETABLE CROPS

Credits 1:0:1

Course objectives:

To impart knowledge on

1. The scenario of temperate vegetable crops
2. The advanced production technologies of temperate vegetable crops
3. The post-harvest handling of temperate vegetable crops

Course outcomes:

At the end of this course, students will be able to

1. Capable to identify the temperate vegetables from tropical vegetables
2. Understand the nutritional importance of cool season vegetables in human nutrition
3. Demonstrate the scientific method of cultivation of major cool season vegetables
4. Aware of hybrids and varieties released from these cool season vegetable
5. Familiar with nutritional and physiological disorder of temperate vegetables
6. Capable to establish and maintain nursery for cool season vegetables

18HO2007 - PRODUCTION TECHNOLOGY OF TEMPERATE FRUIT CROPS

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. The scenario and scope of temperate fruit crops
2. The cultivation aspects of temperate fruit crops
3. The different horticultural practices in cultivation of temperate fruit crops

Course Outcomes:

At the end of this course, students will be able to

1. Identify the different temperate fruit crops and their commercial varieties grown in India
2. Propagate temperate fruit trees using the propagation methods learnt
3. Describe the commercial method of growing temperate fruit crops
4. Elucidation of establishing High Density of Harding
5. Understand the various pruning and training practices for temperate fruit crops
6. Know the various production constraints in temperate fruit crops

18HO2008 - PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. Scope and importance of medicinal and aromatic crops
2. Production technology of medicinal and aromatic plants
3. Various extraction processes, essential oil and their commercial uses

Course Outcomes:

At the end of this course, students will be able to

1. Remember the scientific names and uses of the MAP
2. Elucidate the untapped commercial potential of MAP
3. Explore the scope of MAPS in India and other countries
4. Familiar with government initiatives for the promotion of MAP
5. Familiar with applications of essential oil
6. Explain the medicinal values of MAP in Pharma industry

18HO2009 - BREEDING OF VEGETABLES, MEDICINAL AND AROMATIC CROPS

Credits 3:0:1

Course Objectives:

To impart knowledge on

1. The objectives, concepts, propagation methods and breeding strategies of vegetables, medicinal and aromatic crops
2. The basics of floral biology and hybridization of vegetables, medicinal and aromatic crops
3. The breeding procedures and achievements in crop improvement of vegetables, medicinal and aromatic crops

Course Outcomes:

At the end of this course, the students will be able to

1. Recap the objectives, concepts, propagation methods of vegetables, medicinal and aromatic crops
2. Understand the plant genetic resources conservation and utilization in crop improvement
3. Comprehend the floral biology and pollination mechanism in different plants
4. Apply the methods of breeding in vegetables, medicinal and aromatic crops
5. Develop the breeding strategies for vegetables, medicinal and aromatic crops
6. Understand the achievements in crop improvement of vegetables, medicinal and aromatic crops

18HO2010 - DISEASES OF VEGETABLES, FLOWERS, ORNAMENTAL AND SPICE CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The etiology and symptoms of diseases of the vegetables, flowers, ornamental and spice crops
2. The mode of spread and epidemiology of diseases in vegetables, flowers, ornamental and spice crops
3. The integrated disease management and post-harvest disease management practices

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the etiology of the different diseases of vegetables, flowers, ornamental and spice crops
2. Identify the symptoms of diseases and their mode of spread
3. Apply the various disease management practices of vegetables, flowers, ornamental and spice crops

4. Develop an integrated disease management practices for framing the crop protection strategies
5. Diagnose the important post-harvest diseases
6. Develop a disease management practices for protected cultivation systems and for the post-harvest diseases

18HO2011- INSECT PESTS OF FRUIT, PLANTATION, MEDICINAL & AROMATIC CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The insect ecology and factors responsible for outbreaks of pests in Fruit, Plantation, Medicinal & Aromatic crops
2. The integrated pest management of fruit, plantation, medicinal and aromatic crops
3. The ecology, importance and management practices of storage pests in fruit, plantation, medicinal & aromatic crops

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the ecology and economic importance of pests of fruit, plantation, medicinal & aromatic crops
2. Know the factors responsible for outbreaks of pests
3. Identify the injury symptoms and pests of fruit, plantation, medicinal & aromatic crops
4. Develop an integrated pest management practices for framing the crop protection strategies
5. Understand the ecology and economic importance of storage pests of fruit, plantation, medicinal and aromatic crops
6. Analyze the pesticide residual limits of chemicals used for pest management

18HO2012 - STUDY TOUR – I

Credits 0:0:1

Course Objectives:

To impart knowledge on

1. The socio - economic and cultural aspects of different agroclimatic zones in Tamil Nadu
2. The ongoing horticultural research and extension programs in various research stations/Horticultural Institutions/ Colleges of South India
3. The cropping systems followed in different agro climatic zones

Course Outcomes:

At the end of this course, the students will be able to

1. Compare the socio -economic and cultural aspects of different agricultural zones in Tamil Nadu
2. Identify different soil types and cropping systems for horticultural crops in Tamil Nadu
3. Know the ongoing research activities and experiments conducted in the institutes
4. Recognize demonstration plots and agri – horticultural models
5. Understand the extension programs followed to disseminate the new technologies
6. Apply the knowledge on horticultural crops and cropping systems in the different agro-climatic zones

18HO2013 - PRINCIPLES OF ORNAMENTAL HORTICULTURE AND LANDSCAPE ARCHITECTURE

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The scope and importance of ornamental horticulture and landscaping
2. The styles and designs of traditional and advanced landscape architecture

3. Selection of ornamental crops for cut flower production and floral arrangements and the use of AutoCAD and Arch CAD for garden designing

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the principles of ornamental horticulture and landscape design
2. Explain about the different ornamental crops and its suitability to different landscapes
3. Distinguish the different garden types of India and abroad
4. Create unique lawn, floral arrangements, terrariums, xeriscaping and bonsai designs.
5. Explore the different landscaping designs and architectures using AutoCAD and ArchCAD
6. Identify the factors affecting the landscape design and planning

18HO2014 - DRYLAND HORTICULTURE

Credits: 2:0:1

Course Objectives:

To impart knowledge on

1. The importance and limitations of dryland horticulture
2. The soil and water conservation methods suitable for different agro climatic regions
3. The horticultural crops adapted for dryland cultivation and special cultivation techniques

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the scenario of dryland horticulture in India
2. Describe the different water conservation techniques used
3. Suggest crops suitable for different dryland areas
4. Apply dryland farming techniques for various agro climatic regions
5. Identify the suitable drought resistant crops
6. Adopt the special package of practices for dryland horticultural crops

18HO2015 - BREEDING OF FRUITS AND PLANTATION CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The objectives, concepts, propagation methods and breeding strategies of fruit and plantation crops
2. The advanced hybridization techniques in breeding of fruit and plantation crops
3. The breeding procedures and achievements in crop improvement of fruit and plantation crops

Course Outcomes:

At the end of this course, the students will be able to

1. Outline the objectives, concepts, propagation methods of fruit and plantation crops
2. Understand the plant genetic resources conservation and utilization in crop improvement
3. Develop breeding strategies for fruit and plantation crops
4. Acquire the knowledge in advanced hybridization techniques in breeding
5. Apply the methods of breeding in development of fruit and plantation crops
6. Understand the achievements in crop improvement and the policies involved

18HO2016 - SEED PRODUCTION OF VEGETABLE, TUBER AND SPICE CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The history and growth of seed industry in India
2. The various seed production techniques of important vegetable, tuber and spice crops
3. The seed legislative laws in India

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the role of seed industry and the scope and importance of seed production in vegetable, tuber and spice crops
2. Acquire the knowledge on the role of weather parameters in seed production
3. Identify the suitable techniques for better seed production in vegetable, tuber and spice crops
4. Apply the various seed production techniques in vegetable, tuber and spice crops
5. Demonstrate the seed drying and extraction techniques
6. Understand the different seed legislative laws

18HO2017 - INSECT PESTS OF VEGETABLE, ORNAMENTAL AND SPICE CROPS

Credits 2:0:1

Course Objectives:

To impart knowledge on

1. The insect ecology and factors responsible for outbreaks of pests in vegetable, ornamental and spice crops
2. The integrated pest management of vegetable, ornamental and spice crops
3. The ecology, importance and management practices of storage pests in vegetable, ornamental and spice crops

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the ecology and economic importance of pests of vegetable, ornamental and spice crops
2. Acquire the knowledge on the factors responsible for outbreaks of pests
3. Identify the injury symptoms and pests of vegetable, ornamental and spice crops
4. Develop an integrated pest management practices for framing the crop protection strategies
5. Understand the ecology and economic importance of storage pests of vegetable, ornamental and spice crops
6. Analyze the pesticide residual limits of chemicals used for pest management

18HO2018 - INTRODUCTION TO MAJOR FIELD CROPS

Credits 1:0:1

Course objectives:

To impart knowledge on

1. The classification and distribution of field crops
2. The concepts of various cropping systems and its application
3. The different cultural practices for the cultivation of major field crops

Course outcomes:

At the end of this course, the students will be able to

1. Understand the classification and distribution of major field crops
2. Identify the field crops, fodder crops and green manure crops
3. Understand the concepts of various cropping systems followed in crop production
4. Apply the cultivation practices of major field crops
5. Adopt the nutrient and weed management practices for effective use
6. Describe the cultural practices of fodder and green manure crops

18HO2019 - ECONOMICS AND MARKETING

Credits: 2:0:1

Course objectives:

To impart knowledge on

1. The concepts of agricultural market structure and its classification
2. The theories of demand and supply of agricultural produce in market-oriented economy
3. The marketing of agricultural produce and preparation of individual projects

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the consumption, demand and supply in agricultural economics

2. Recall the concepts of agricultural marketing
3. Identify the factors affecting the agricultural production
4. Understand the marketing margin and marketing functions
5. Apply the knowledge on market intelligence, SWOT analysis and financial crisis management
6. Prepare a project proposals and project reports using techno – economic parameters

18HO2020 - HORTI-BUSINESS MANAGEMENT

Credits: 2:0:0

Course Objectives:

To impart knowledge on

1. Farm and business management principles
2. Applying economic principles to organization and management of businesses with emphasis on choice of optimal enterprise combinations
3. Functional areas of management

Course Outcome

At the end of this course, the students will be able to

1. Recall farm and business management concepts
2. Analyze the time value of money
3. Apply economic principles applicable in farm management
4. Understand the functional areas of management
5. Gain knowledge on planning, marketing programs
6. Prepare financial statements, budgeting and project management

18HO2021 - POSTHARVEST MANAGEMENT AND PROCESSING OF HORTICULTURAL CROPS

Credits 2:0:2

Course Objectives

To impart knowledge

1. The broad spectrum of opportunities in Post-Harvest Technology and Processing and its glitches
2. Post and pre harvest physiological changes in horticultural crops
3. Pre- and post-harvest treatments to manage the physiological processes

Course outcomes:

At the end of this course, the students will be able to

1. Understand the various processing techniques
2. Identify the post-harvest physiological problems and address the issue
3. Prepare few basic processed foods and improve its value
4. Explain storage and packaging technology
5. Become aware of the government policies on export and import
6. Utilize the opportunities in PHT to start a small unit

18HO2023 - NEMATODE PESTS OF HORTICULTURAL CROPS AND THEIR MANAGEMENT

Credits 1:0:1

Course Objectives

To impart knowledge on

1. The taxonomical classification and characterization of parasitic nematodes
2. Symptomology and control measures of nematode
3. The best nematode control practices using INM

Course Outcomes:

At the end of this course, students will be able to

1. Have a clear knowledge about the various morphological and taxonomical classifications of nematode

2. Identify the type of nematodes based on morphology and symptoms
3. Identify the nematode symptoms in plants and suggest suitable INM practices
4. Understand the nematode disease complexes in plants
5. Apply the INM practices in the field
6. Analyze and develop advanced nematode control measures

18HO2024 - APICULTURE, SERICULTURE AND LAC CULTURE

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Importance of different beneficial insects such as honey bee, silkworm and lac insect
2. Detailed classification, life cycle and behavior of honey bee, silkworm and lac insect
3. Technology and economics of honey, silk and lac production

Course Outcomes:

At the end of this course, students will be able to

1. Remember the species, life cycle of the beneficial insects
2. Identify the different species of honey bee and silkworm
3. Thorough knowledge of the colonial behavior of honey bee and the production of honey
4. Describe the silkworm production, maintenance and practical problems in the production
5. Elaborate the knowledge on lac culture production and its problems
6. Understand the basics and economics needed to start and maintain apiary or silkworm or lac unit

18HO2025 - STUDY TOUR – II

Credits 0:0:1

Course Objectives:

To impart knowledge on

1. State Agricultural Universities, research centers and private industries
2. Current research, problems and solutions on which the scientist work on
3. Different climatic zones, soils and the crop associated with it

Course outcomes:

At the end of this course, the students will be able to

1. Understand the current research in the horticultural field
2. Comprehend the zone-specific crops and horticultural practices
3. Use the contacts of research institutes and companies for his career advancement
4. Approach a problem and suggest practical solutions to the problems faced by the farmers
5. Demonstrate social, leadership and responsibility qualities
6. Develop skills to co exists in a group

18HO2026 - Entrepreneurship Development and Business Management

Credits: 1:0:1

Course Objectives:

To impart knowledge on

1. The entrepreneurial spirit and orientation towards becoming an entrepreneur
2. The agri-business opportunities that are commercially successful and the procedures involved in start-ups
3. The art and science of business plan and project formulation

Course Outcomes

At the end of this course, the students will be able to

1. Distinguish different entrepreneurial traits and skills
2. Know the agribusiness opportunities open for agriculture graduates
3. Apply the leadership skills to get financial support for start-ups
4. Understand the impact of economic reforms in agri-business
5. Perform SWOT analysis of an entity for any prospective agribusiness/ideas

6. Formulate business proposal for successful implementation of the business plan

B.Tech Agricultural Engineering
REVISED COURSE OBJECTIVES AND OUTCOMES FOR APPROVED COURSES

1	18AT2001	Fluid Mechanics and Open Channel Hydraulics	3:0:1
2	18AT2003	Post-Harvest Engineering of Cereals, Pulses and Oilseeds	2:0:0
3	18AT2004	Farm Machinery and Equipment-I	2:0:1
4	18AT2005	Tractor Systems and Controls	2:0:0
5	18AT2006	Farm Machinery and Equipment-II	2:0:1
6	18AT2007	Field Operation and Maintenance of Tractors and Farm Machinery	0:0:2
7	18AT2008	Post-Harvest Engineering of Horticultural Crops	2:0:0
8	18AT2009	Soil and Water Conservation Engineering	2:0:1
9	18AT2010	Fundamentals of Renewable Energy Sources	2:0:0
10	18AT2011	Extension Methodology and Transfer of Technology	2:0:0
11	18AT2012	Dairy and Food Engineering	2:0:1
12	18AT2013	Storage Structures and Packaging Technology	2:0:1
13	18AT2015	Ground water, Wells and Pumps	2:0:1
14	18AT2016	Water Harvesting and Soil Conservation Structures	2:0:1
15	18AT2017	Bio Energy Systems: Design and Applications	2:0:1
16	18AT2018	Irrigation and Drainage Engineering	2:0:1
17	18AT2020	Process Engineering for Spices and Plantation Crops	2:0:0
18	18AT2022	Process Equipment design	2:0:0
19	18AT2023	Development of Processed Products	2:0:0
20	18AT2024	Farm Machinery Design and Production	2:0:0
21	18AT2025	Tractor Design and Testing	2:0:0
22	18AT2026	Mechanics of Tillage and Traction	2:0:0
23	18AT2028	Drip and Sprinkler Irrigation-Design and Installation	0:0:10
24	18AT2029	Watershed Management-Concept and Strategies	0:0:10
25	18AT2030	Precision Farming in the Semi-arid and Humid Tropical Zones	0:0:10
26	18AT2031	Minor Irrigation and Command Area Development	0:0:10
27	18AT2032	Landscape Irrigation Design and Management	0:0:10
28	18AT2033	Agro-Industry Design and Management	0:0:10
29	18AT2034	Farm Machinery and Power	1:0:1
30	18AT2036	Skill Development Training-I (Student ready)	0:0:5
31	18AT2037	10-weeks industrial attachment/Internship (Student ready)	0:0:10
32	18AT2038	10-Weeks Experiential Learning on campus (Student ready)	0:0:10
33	18AT2039	Skill development training-II (Student ready)	0:0:5
34	18AT2040	Educational tour	0:0:2
35	18AT2041	Project Planning and Report Writing	0:0:10
36	18AT2042	Renewable Energy and Green Technology	1:0:1
37	18AT2043	Protected Cultivation and Secondary Agriculture	1:0:1
38	18AT2044	Water Quality and Management Measures	2:0:0
39	18AT2045	Basics of MATLAB Programming	2:0:0
40	18AT2046	Farm mechanization – Field study	0:0:10
41	18AT2047	Testing of Farm Machinery and Equipments	0:0:10
42	18AT2048	Value Addition of Indigenous Fruits and Vegetables	0:0:10
43	18AT2049	Applications of Solar and Wind Energy in Agriculture	3:0:0

18AT2001 - FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS

Credits 3:0:1

Course Objectives

To impart knowledge on

1. Basic principles, fundamental concepts and theories of fluid mechanics
2. Static, kinematics and dynamic aspects of fluids
3. Fluid flow and flow measurements

Course Outcomes

The students will be able to

1. Apply the knowledge on dynamics of fluid properties
2. Build the knowledge on applicability of physical laws in addressing problems in hydraulics
3. Apply their knowledge on design of irrigation channels
4. Explain the dynamics of fluid flow
5. Estimate the heat loss in pipes
6. Apply their knowledge in measurements of irrigation channels

18AT2003 - POST-HARVEST ENGINEERING OF CEREALS, PULSES AND OILSEEDS

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Various post-harvest techniques of paddy, pulses and oilseeds
2. Basic concept of various unit operation in processing
3. Utilization of by-product obtained during processing

Course Outcomes

The students will be able to

1. Apply knowledge on paddy processing and modern rice milling equipments
2. Acquire knowledge in addressing problems of processing food grains
3. Apply their knowledge on selection of equipments for various unit operations
4. Apply skills to develop value added products from by-products
5. Develop the knowledge in milling of pulses
6. Select the appropriate milling techniques for oilseeds

18AT2004 - FARM MACHINERY AND EQUIPMENT-I

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Farm mechanization benefits and constraints
2. Identification of components in implements
3. Working principles of farm equipments and tillage implements

Course Outcomes

The students will be able to

1. Gain knowledge in mechanization of agricultural farms
2. Estimate the economics of machinery usage
3. Measure the draft of tillage implements
4. Experiment with different equipments used in agricultural fields in tillage and planting
5. Gain knowledge on selection of equipments for various operations
6. Select materials for the construction of farm machines

18AT2005 -TRACTOR SYSTEMS AND CONTROLS

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Tractor and its various systems, their principles of operation and types
2. Concept of traction and mechanics of tractor
3. Ergonomic and safety considerations in tractors and tractor testing

Course Outcomes

The students will be able to

1. Examine the various components of tractors
2. Explain the working of different functional systems of tractor
3. Identify and rectify the problems in functioning of tractor
4. Determine the speed ratio, braking torque and turning radius of tractor
5. Explain the tractor mechanics
6. Test the proper functioning of the tractor along with ergonomic aspects

18AT2006 - FARM MACHINERY AND EQUIPMENT-II

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Farm mechanization benefits and constraints
2. Identification of components of implements
3. Working principles of farm equipment during field operations

Course Outcomes

The students will be able to

1. Demonstrate the working principle of plant protection equipments and intercultivation equipments
2. Examine working of various harvesting equipments
3. Identify and rectify the problems affecting the threshing efficiency
4. Demonstrate the working principles of root crop harvesters
5. Elaborate the working of vegetable and fruit harvester
6. Develop new harvesting machineries

18AT2007 - FIELD OPERATION AND MAINTENANCE OF TRACTORS AND FARM MACHINERY

Credits 0:0:2

Course Objectives

To impart knowledge on

1. Agricultural tractors and power tillers, its systems, operation, maintenance and safety precautions
2. Applications of different farm machinery in the field on tillage, sowing, plant protection, harvesting and threshing
3. Dismantling and reassembling, care, maintenance and safety of farm machines

Course Outcomes

The students will be able to

1. Solve the problems in working of functional systems of tractor
2. Recommend precautionary measures for long run of tractors
3. Illustrate the adjustments needed for the safe working of tillage implements
4. Demonstrate the care and maintenance of agricultural machinery during on and off season
5. Explain the working of trail type trolley
6. Develop an agro service center for farm machinery equipments

18AT2008 - POST-HARVEST ENGINEERING OF HORTICULTURAL CROPS

Credits 2:0:0

Course Objectives:

To impart knowledge on

1. Importance of processing of horticultural crops
2. Processing and packaging methods of horticultural crops
3. Preparation and preservation of finished products and quality control in fruit and vegetable processing industry

Course Outcomes:

The students will be able to

1. Explain the importance of fruits, vegetables, spices, condiments and flower processing
2. Describe the process and methods of peeling, slicing and blanching
3. Describe the process of chilling, freezing and cold storage
4. Describe methods of drying and dehydration
5. Comprehend packaging requirements, packaging methods/machines, handling and transportation
6. Evaluate the preservation techniques/ methods and quality control for perishable products

18AT2009 - SOIL AND WATER CONSERVATION ENGINEERING

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Concepts and causes of erosion and the problems associated with it
2. Use of the principles and concepts to solve issues related to soil and water management
3. Proper application of different soil and water conservation measures to restore the productivity of the soil

Course Outcomes

The students will be able to

1. Gain fundamental knowledge on the concepts of erosion and sedimentation
2. Gain sufficient knowledge on soil loss control, water conservation and augmentation of water sources
3. Design various soil and water conservation measures
4. Analyze basic causes of soil erosion and the relevant mitigation strategies
5. Design appropriate watershed-based soil conservation structures and rainwater harvesting systems
6. Understand hydrologic, hydraulic and structural designs of soil and water conservation measures and rainwater harvesting systems

18AT2010 - FUNDAMENTALS OF RENEWABLE ENERGY SOURCES

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Energy use and its environmental impact
2. Classifications of major renewable energy sources and technologies
3. Alternate energy sources (solar energy and wind energy) and their applications

Course Outcomes

The students will be able to

1. Understand the concepts of bio energy sources and its applications
2. Classify the various conventional and renewable energy sources
3. Apply their knowledge on the design of solar energy systems
4. Explain the principle of wind power plan
5. Explain the concepts of biomass gasification
6. Develop a biogas plant

18AT2011 - EXTENSION METHODOLOGIES AND TRANSFER OF AGRICULTURAL TECHNOLOGY

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Extension and basic communication skills
2. Transfer of technology using extension technologies
3. Transferring technologies in the field

Course Outcomes

The students will be able to

1. Understand the basic concepts of extension and basic communication skills
2. Understand Audio-visual aids
3. Gain knowledge on transfer of technology using extension technologies
4. Handle extension methods
5. Make use of modern communication techniques
6. Understand the concept and theory of adoption and diffusion

18AT2012 - DAIRY AND FOOD ENGINEERING

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Properties, processing and packaging of milk
2. Milk processing equipments
3. Production of dairy products and the equipments used

Course Outcomes

The students will be able to

1. Understand the various milk processing methods
2. Examine different properties of milk and milk products
3. Explain the working of milk processing equipments
4. Demonstrate hands-on skills in manufacturing selected dairy products in a pilot plant setting
5. Understand the importance of thermal and non-thermal processing in food processing industry
6. Describe milk packaging machines

18AT2013 - STORAGE STRUCTURES AND PACKAGING TECHNOLOGY

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Different storage techniques
2. Packing and packaging materials
3. Working of various packaging methods

Course Outcomes

The students will be able to

1. Learn the need for adoption of scientific storage methods
2. Construct storage structures for food commodities according to the requirement
3. Prove the advantages of modern storage structures with traditional storage structures
4. Understand the functions of packaging material
5. Apply the knowledge on advance food packaging methods and their application in food industry
6. Explain the principle and need for testing of packaging materials

18AT2015 - GROUND WATER, WELLS AND PUMPS

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Occurrence, development and hydraulics of ground water flow
2. Theory and applications of well and pump
3. Area of well design, construction and management of well

Course Outcomes

The students will be able to

1. Gain knowledge on technical aspects of groundwater, its availability, assessment and utilization
2. Explain groundwater occurrence, its storage and movement alongside exploration
3. Explain the theory behind well design
4. Explain the management of well
5. Explain theories behind well construction and maintenance
6. Apply appropriate groundwater quality management techniques

18AT2016 - WATER HARVESTING AND SOIL CONSERVATION STRUCTURES

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Water harvesting techniques based on source, storage and use
2. Soil and water conservation structures
3. Design requirements, planning for design, design procedures and stability analysis of different structures

Course Outcomes

The students will be able to

1. Gain fundamental knowledge on the concepts of water harvesting
2. Apply their knowledge in the design of farm pond
3. Design the percolation ponds
4. Apply their knowledge in the construction of permanent gully control structures
5. Explain the different types and uses of drop spillway
6. Explain the design criteria of chute spillway

18AT2017 - BIO ENERGY SYSTEMS: DESIGN AND APPLICATIONS

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Basic principles of bio-energy systems
2. Importance of bio resources, bio energy and reactors
3. Design and operation of major bio-energy systems

Course Outcomes

The students will be able to

1. Understand the concepts of bio energy sources and its applications
2. Recommend solutions for bio-mass conversion into energy
3. Apply their technical know-how for the design of bio energy systems
4. Gain knowledge on production of clear and concise analyses of benefits and problems relating to the production and use of different forms of biomass energy
5. Understand the energy-generating potential of biomass as an energy source used in different ways
6. Design biomass-driven power generation and biofuel production and be able to narrow the focus of design choices in a particular context

18AT2018 - IRRIGATION AND DRAINAGE ENGINEERING

Credits 2:0:1

Course Objectives

To impart knowledge on

1. Design water conveyance systems and surface irrigation systems in the field
2. Planning, designing and management of land drainage works in cultivated areas
3. Various methods of land drainage and its impact on environment

Course Outcomes

The students will be able to

1. Gain knowledge and skills on planning, designing, operation and management of reservoir system
2. Explain different methods of irrigation
3. Design proper drainage systems in the field
4. Understand the hydrologic cycle, principles and manage the water resources
5. Apply appropriate techniques for irrigation and drainage systems
6. Test and analyze agricultural irrigation and drainage systems and their components

18AT2020 - PROCESS ENGINEERING FOR SPICES AND PLANTATION CROPS

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Processing of major and minor spices, plantation crops and medicinal plants
2. Various equipments involved in processing
3. Packaging and storage of spices and value-added products

Course Outcomes

The students will be able to

1. Gain knowledge in different unit operations and its equipment involved in processing of major and minor spices
2. Develop value added products from plantation crops and spices
3. Demonstrate different techniques for spices and plantation crops with minimum post-harvest losses
4. Acquire knowledge on importance of medicinal crops
5. Describe extraction methods with quality standards
6. Apply the knowledge on packaging and storage of spices

18AT2022 - PROCESS EQUIPMENT DESIGN

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Design and development of the food processing equipments
2. Relationship between process design and safety.
3. Computer aided design of equipments

Course Outcomes

The students will be able to

1. Understand the factors affecting the design of an equipment
2. Select an appropriate type of materials needed for development of equipment
3. Assess the critical variables for the design of equipments
4. Develop a conceptual design models
5. Design material handling equipments
6. Design heat exchangers and dryers using in food processing industry.

18AT2023 - DEVELOPMENT OF PROCESSED PRODUCTS

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Various unit operations in development of new products
2. Development of value added products
3. Importance of functional, nutraceutical foods and organic foods

Course Outcomes

The students will be able to

1. Understand the concepts of new product development
2. Apply knowledge gained in formulating value added products
3. Develop new products which are healthy and nutritional
4. Describe the importance of functional foods
5. Design and develop new processes and products from cereals, pulses, oilseeds, fruits and vegetables
6. Develop new organic foods

18AT2024 - FARM MACHINERY DESIGN AND PRODUCTION

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Design aspects of farm machinery and implements
2. Production of farm machinery
3. Cutting tools and manufacturing techniques

Course Outcomes

The students will be able to

1. Design different functional components of tractor
2. Construct system components according to the specified needs
3. Test the production of agricultural machinery
4. Develop the research-based knowledge in design aspects of farm machinery
5. Describe advance manufacturing techniques
6. Utilize CNC tools for manufacturing

18AT2025 - TRACTOR DESIGN AND TESTING

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Design of tractors
2. Traction theory
3. Testing procedures of tractor

Course Outcomes

The students will be able to

1. Apply the knowledge in designing of tractor for stability
2. Design the hitching systems of tractor
3. Develop power transmission systems of tractor
4. Design the IC engine components
5. Design the steering systems of the tractor
6. Test the farm tractors in various aspects

18AT2026 - MECHANICS OF TILLAGE AND TRACTION

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Concepts of the mechanics and traction

2. Design of tillage tools
3. Static and dynamic soil parameters

Course Outcomes**The students will be able to**

1. Understand the concepts of the mechanics of tillage and traction
2. Interpret the power requirement for tillage
3. Apply the principles and concepts of mechanics of tillage in designing the tillage tools
4. Apply dimensional analysis in soil dynamics and traction prediction
5. Explain the traction and mechanics for off road traction and mobility
6. Describe the effects of tractor tyre, lug geometry and size on tillage and traction

18AT2028 - DRIP AND SPRINKLER IRRIGATION-DESIGN AND INSTALLATION**Credits 0:0:10****Course Objectives****To impart knowledge on**

1. Basic concepts on drip and sprinkler irrigation systems
2. Various components of drip and sprinkler irrigation systems
3. Design and installation of drip and sprinkler irrigation systems

Course Outcomes**The students will be able to**

1. Understand the basic concepts on drip and sprinkler irrigation systems
2. Gain knowledge on the various components of drip and sprinkler irrigation systems
3. Design and install drip and sprinkler irrigation systems
4. Compute peak crop water requirement
5. Gain knowledge on hydraulic design of the system in terms of lateral, sub-main and main lines
6. Demonstrate the horse power requirement and uniformity of water application

18AT2029 - WATERSHED MANAGEMENT-CONCEPT AND STRATEGIES**Credits 0:0:10****Course Objectives****To impart knowledge on**

1. Watershed management
2. Various strategies for watershed management
3. Planning and execution of watershed management projects

Course Outcomes**The students will be able to**

1. Understand the basic concepts and ideas about watershed management
2. Gain knowledge on the various strategies for watershed management
3. Capable of planning and execution of watershed management projects
4. Develop better systems for the integration of biophysical and socio-economic data
5. Understand the effects of privatization and valuation of public resources on the complex interactions in watersheds
6. Explain collective definitions of water rights and their effects on watershed management

18AT2030 - PRECISION FARMING IN THE SEMI-ARID AND HUMID TROPICAL ZONES**Credits 0:0:10****Course Objectives****To impart knowledge on**

1. Technology of precision farming
2. Various system concepts in precision farming
3. Planning and execution precision farming techniques using modern techniques

Course Outcomes**The students will be able to**

1. Understand the basic concepts and technology of precision farming
2. Choose the different equipment's for precision farming
3. Explain the GIS based precision agriculture
4. Understand the database management system
5. Analyze and rectify the problems related to precision farming
6. Plan and execute precision farming techniques

18AT2031 - MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT**Credits 0:0:10****Course Objectives:****To impart knowledge on**

1. Basic concepts of irrigation management and command area development
2. Functioning of irrigation projects and their performance aspects
3. Activities of command area development and on farm irrigation activities

Course Outcomes:**The students will be able to**

1. Understand concepts of tank irrigation systems
2. Design lift irrigation systems
3. Plan and execute the command area development and on farm irrigation activities
4. Analyze the functions and performance of command area development
5. Apply the remote sensing techniques for command area development
6. Propose layout for command area development

18AT2032 - LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT**Credits 0:0:10****Course Objectives:****To impart knowledge on**

1. Basic concepts of landscape design
2. Design aspects of landscape
3. Design and implementation of landscape irrigation and management

Course Outcomes:**The students will be able to**

1. Understand basic concepts of landscape irrigation
2. Choose the appropriate irrigation methods for different types of landscapes
3. Select suitable pipes with appropriate pressure rating and sizing
4. Analyze the water requirement for different landscape
5. Describe automation in landscape irrigation
6. Design landscape irrigation systems

18AT2033 - AGRO PROCESSING INDUSTRY- DESIGN AND MANAGEMENT**Credits 0:0:10****Course Objectives****To impart knowledge on**

1. Various factors involved in the site selection and design concepts of food plant layout
2. Production, finance and marketing of a food plant
3. Current trends followed in food processing industry

Course Outcomes**The students will be able to**

1. Design and setup new food processing plant as an entrepreneur
2. Develop hands on skills in manufacturing of selected milk products
3. Identify new strategies for marketing of food products
4. Apply the knowledge gained in formulating value added products

5. Develop skills in design of modern rice mill and bakery related products
6. Organize project reports

18AT2034 - FARM MACHINERY AND POWER

Credits 1:0:1

Course Objectives

To impart knowledge on

1. Different systems of IC engines and its working
2. Various farm implements from tillage to harvesting
3. Selection of farm implements and its cost benefit analysis

Course Outcomes

The students will be able to

1. Analyze the working of two stroke and four stroke IC engines
2. Solve problems in the functioning of farm implements
3. Select an appropriate tillage implements needed for the farm
4. Experiment with different equipments used in agricultural fields from planting to harvesting
5. Predict the cost benefit economics of various farm implements
6. Illustrate the need of farm mechanization

18AT2036 - SKILL DEVELOPMENT TRAINING-I (STUDENT READY)

Credits 0:0:5

Course Objectives

1. To train the students on skill development
2. To create opportunities and scope for the development of the talents of the students
3. To improve on self-entrepreneurship

Course Outcome

The students will be able to

1. Build technical skills
2. Plan for job opportunities during the training
3. Demonstrate various applications of farm implements to the farmers
4. Understand the practical problems and remedial measures
5. Identify the method of improvement of the process in the field
6. Develop hands on skills in the different sectors of manufacturing, production and processing

Contents

The students will have hands on training and thorough knowledge on practical applications of farm mechanization, design of implements, automation of irrigation systems, processing of food and dairy products, utilization of energy sources in agricultural and industrial sectors.

Summer break after IV semester -Student READY Skill Development Training -I for five weeks in the summer break after IV semester with a credit load of 0+5 credit hours.

18AT2037 10-WEEKS INDUSTRIAL ATTACHMENT/INTERNSHIP (STUDENT READY)

Credits 0:0:10

Course Objectives

1. To impart training in industries
2. To develop technical skills
3. To improve on self-entrepreneurship

Course Outcome

The students will be able to

1. Develop their entrepreneur skills
2. Develop the implements with desired specifications
3. Improve their technical skills
4. Explain the manufacturing technology of different farm implements and tractor
5. Design different irrigation systems
6. Gain hands on training in dairy and processing industries

Technology and globalization are ushering an era of unprecedented change. The need and pressure for change and innovation is immense. To enrich the practical knowledge of the students, in-plant training shall be mandatory in the last semester for a period of up to 10 weeks. In this training, students will have to study a problem in industrial perspective and submit the reports to the university. Such in-plant trainings will provide an industrial exposure to the students as well as to develop their career in the high-tech industrial requirements. In-plant training is meant to correlate theory and actual practices in the industries. It is expected that sense of running an industry may be articulated in right way through this type of industrial attachment mode.

Semester VII - Industrial attachment of 10 weeks with local industries.

18AT2038 10-WEEKS EXPERIENTIAL LEARNING ON CAMPUS (STUDENT READY)

Credits 0:0:10

Course Objectives

1. To conduct trials in the field for onsite learning
2. To create conceptual knowledge and adaptive skills
3. To gain practical experience and proper planning for execution of work

Course Outcome

The students will be able to

1. Focus on results of the learning experiences
2. Reflect the desired end of the learning experience, not the means or the process
3. Represent the minimum performances that must be achieved to successfully complete a program
4. Get confidence and answer the question of the concerned field
5. Prepare farm products of desired specification
6. Evaluate the quality of the prepared products

Semester VIII - On campus Experiential Learning Program (ELP) of 10 weeks with a credit load of 0+10 credit hours by selecting subjects given in the syllabus.

EVALUATION PATTERN FOR COURSE 18AT2038

The evaluation pattern is given below to get approval from the standing committee.

Total marks (100%)

1. Attendance	= 10 *
2. Internal assessment/Presentation	= 40
3. Evaluation of report	= 40
4. Viva-Voce examination	= 10
Total	= 100

(Note: *85% attendance is required for eligibility to award marks/grade)

18AT2039 SKILL DEVELOPMENT TRAINING-II (STUDENT READY)

Credits 0:0:5

Course Objectives

1. To train the students on skill development
2. To create opportunities and scope for the development of the talents of the students
3. To improve on self-entrepreneurship

Course Outcome

The students will be able to

1. Build technical skills
2. Plan for job opportunities during the training
3. Demonstrate various applications of farm implements to the farmers
4. Understand the practical problems and give remedial measures
5. Identify the method of improvement of the process in the field
6. Develop hands on skills in the different sectors of manufacturing, production and processing

Contents

Using a process that enables individuals to recognize the skills they have and to get a qualification for those skills. It also identifies skill gaps and provides individuals with a training plan to progress along the career pathway or gain the skills. The students will have hands on training and thorough knowledge on practical applications of farm mechanization, design of implements, automation of irrigation systems, processing of food and dairy products, utilization of energy sources in agricultural and industrial sectors.

Summer break after VI semester- Student READY Skill Development Training -II for five weeks in the summer break after VI semester

EVALUATION PATTERN FOR COURSES 18AT2036, 18AT2037 AND 18AT2039

The evaluation pattern is given below to get approval from the standing committee.

Total marks (100%)

1.Attendance	= 10 *
2. Internal assessment/presentation	= 40
3. Evaluation of report	= 40
4.Viva-Voce examination	= 10
Total	= 100

(Note: *80% attendance is required for eligibility to award marks/grade)

18AT2040 - EDUCATIONAL TOUR

Credits 0:0:2

Course Objective:

To expose the various research organizations to gain on the field knowledge

Content

Visit to places of interest in Tamil Nadu & Pondicherry states related to the subjects taught in farm machinery and power, soil and water conservation engineering, food and agricultural process engineering, bio energy and agricultural structures.

18AT2041 - PROJECT PLANNING AND REPORT WRITING

Credits 0:0:10

Course Objective:

To prepare the student for project and field study of selected topic.

Content

Identification of problem – literature collection – fabrication of equipments – land preparation – preliminary testing of equipments / layout of irrigation trails – parametric data collection.

18AT2042 - RENEWABLE ENERGY AND GREEN TECHNOLOGY

Credits 1:0:1

Course Objectives:

To impart knowledge on

1. Concept of renewable energy
2. The various green technology techniques
3. Technical know-how on renewable energy measures

Course Outcomes:

The students will be able to

1. Gain the basic knowledge of solar energy harvesting
2. Familiarize with different types of solar energy gadgets
3. Understand the contributions of energy sources to agriculture
4. Remember different types of biogas production structures
5. Design renewable energy structures
6. Describe the green energy techniques

18AT2043 - PROTECTED CULTIVATION AND SECONDARY AGRICULTURE

Credits 1:0:1

Course Objectives

To impart knowledge on

1. Basics of protected cultivation
2. Various techniques involved in protected cultivation
3. Technical know-how on secondary agriculture

Course Outcomes

The students will be able to

1. Plan and design low-cost green houses
2. Predict the plant responses to greenhouse environment
3. Estimate the cost benefit economics of protected cultivation
4. Understand engineering properties of food materials
5. Explain the working of commercial grain dryers
6. Illustrate the material handling equipments

18AT2044 - WATER QUALITY AND MANAGEMENT MEASURES

Credits 2:0:0

Course Objectives

To impart knowledge on

1. Basics of water and its quality
2. Various techniques involved in water quality testing
3. Technical know-how on managing water quality

Course Outcomes

The students will be able to

1. Understand the basics of water quality
2. Find measures to solve water quality
3. Design methods to find solutions for water testing
4. Outline the sources of water contamination
5. Explain different water management practices
6. Explain water quality standard

18AT2045 - BASICS OF MATLAB PROGRAMMING

Credits 2:0:0

Course objectives:

To impart knowledge on

1. Fundamentals of MATLAB
2. Simulation and modeling
3. Dynamics and control

Course outcomes:

The students will be able to

1. Understand the MATLAB programming
2. Study various methods of plotting
3. Compute solutions using simulations and modelling
4. Familiar with memory and file management in Matlab
5. Generate plots and export this for use in reports and presentations
6. Program scripts and functions using the Matlab development environment

18AT2046 - FARM MECHANIZATION – FIELD STUDY

Credits 0:0:10

Course Objectives

To impart knowledge on

1. Farm mechanization
2. Farm machinery for different crops

3. Economics of using agricultural machinery

Course Outcomes**The students will be able to**

1. Understand the various farm machinery usage in farms
2. Gain knowledge on farm mechanization
3. Apply their knowledge in periodic maintenance tractors
4. Learn about different sources of farm power, construction and functioning of CI and SI engines
5. Develop and modify indigenous farm machines as per the need of the area and farmers
6. Acquire knowledge regarding makes and models of tractors

18AT2047 - TESTING OF FARM MACHINERY AND EQUIPMENTS**Credits 0:0:10****Course Objectives****To impart knowledge on**

1. Testing of farm machinery
2. Economics of farm equipments
3. Testing various farm machineries

Course Outcomes**The students will be able to**

1. Understand the various methods of testing farm implements
2. Explain the application of testing farm equipments
7. Develop an agro service center for farm machinery equipments
3. Determine the comparative performance of machine
4. Decide the type of machine best suited for Indian conditions
5. Form the basis for standard specification to be used by the manufacturers

18AT2048 - VALUE ADDITION OF INDIGENOUS FRUITS AND VEGETABLES**Credits 0:0:10****Course Objectives****To impart knowledge on**

1. Basics of value addition of fruits and vegetables
2. Methods of preserving fruits and vegetables
3. New product development

Course Outcomes**The students will be able to**

1. Understand basic concepts of value addition
2. Apply the knowledge in processing of indigenous fruits and vegetables
3. Prepare project reports for setting processing units for indigenous fruits and vegetables
4. Gain knowledge about new product development
5. Apply the knowledge in new product development
6. Analyze the different processing and preservation techniques

**18AT2049 - APPLICATIONS OF SOLAR AND WIND ENERGY IN AGRICULTURE
(Compulsory Elective)****Credits: 3:0:0****Course Objectives:****To impart knowledge on**

1. Principles and applications of solar and wind energy in agriculture
2. Concept of photovoltaic technology
3. Wind mapping analysis

Course Outcomes:**The students will be able to**

1. Understand the applications of solar energy in agriculture

2. Describe solar pump for irrigation systems
3. Know about the applications of wind energy in agriculture
4. Familiar with the idea of photovoltaic technology
5. Analyze wind mapping
6. Gain sufficient knowledge on different alternate energy sources

**DEPT. OF
AGRICULTURE**

LIST OF COURSES

S.No.	Course Code	Name of the Course	Credits
Agriculture			
1	18AG1001	Fundamentals of Agronomy	3:0:1
2	18AG1002	Agricultural Heritage	1:0:0
3	18AG1003	Introductory Agricultural Meteorology and Climate Change	1:0:1
4	18AG2004	Production Technology for Vegetables	1:0:1
5	18AG1005	Agricultural Microbiology	2:0:1
6	18AG2006	Agri Informatics	1:0:1
7	18AG2007	Farming Systems and Sustainable Agriculture	1:0:0
8	18AG1008	Principles of Genetics and Cytogenetics	2:0:1
9	18AG1009	Fundamentals of Crop Physiology	2:0:1
10	18AG2010	Production Technology for Fruits and Plantation Crops	1:0:1
11	18AG1011	Fundamentals of Entomology	2:0:1
12	18AG1012	Fundamentals of Agricultural Economics	2:0:0
13	18AG1013	Fundamentals of Soil Science	2:0:1
14	18AG1014	Fundamentals of Agricultural Extension Education	2:0:1
15	18AG1015	Introduction to Agriculture and Horticulture	2:0:0
16	18AG1016	Introductory Agro Forestry	1:0:1
17	18AG1017	Weed Management	1:0:1
18	18AG1018	Production Technology for Vegetable, Fruit and Plantation Crops	2:0:1
19	18AG2001	Principles of Plant Breeding	2:0:1
20	18AG2002	Crop Production Technology – I (Kharif Crops)	1:0:1
21	18AG2003	Agricultural Finance and Cooperation	2:0:1
22	18AG2004	Production Technology for Vegetables	1:0:1
23	18AG2005	Livestock and Poultry Management	3:0:1
24	18AG2006	Agri Informatics	1:0:1
25	18AG2007	Farming Systems and Sustainable Agriculture	1:0:0
26	18AG2008	Crop Production Technology –II (Rabi Crops)	1:0:1
27	18AG2009	Production Technology for Ornamental Crops and Landscaping	1:0:1
28	18AG2010	Production Technology for Fruit and Plantation Crops	1:0:1
29	18AG2011	Principles of Seed Technology	1:0:1
30	18AG2012	Problematic Soils and their Management	2:0:0
31	18AG2013	Agricultural Marketing, Trade and Prices	2:0:1
32	18AG2014	Introduction to Biotechnology	1:0:1
33	18AG2015	Environmental Studies and Disaster Management	2:0:1
34	18AG2016	Medicinal, Spices and Aromatic Plants	1:0:1
35	18AG2017	Study Tour – I	0:0:1
36	18AG2018	Practical Crop Production (Kharif crops)	0:0:2
37	18AG2019	Crop Improvement – I (Kharif crops)	1:0:1
38	18AG2020	Manures, Fertilizers and Soil Fertility Management	2:0:1
39	18AG2021	Diseases of Field and Horticultural Crops and their Management –I	2:0:1
40	18AG2022	Principles of Integrated Pest and Disease Management	2:0:1
41	18AG2023	Pests of Crops, Stored Grains and their Management	2:0:1
42	18AG2024	Precision Farming	1:0:1
43	18AG2025	Entrepreneurship Development and Business Management	1:0:1

44	18AG2026	Intellectual Property Rights	1:0:0
45	18AG2027	Rainfed Agriculture and Watershed Management	1:0:1
46	18AG2028	Practical Crop Production (Rabi crops)	0:0:2
47	18AG2029	Principles of Organic Farming	1:0:1
48	18AG2030	Diseases of Field and Horticultural Crops and their Management –II	1:0:1
49	18AG2031	Post-harvest Management and Value Addition of Fruits and Vegetables	2:0:1
50	18AG2032	Crop Improvement - II (Rabi crops)	1:0:1
51	18AG2033	Management of Beneficial Insects	1:0:1
52	18AG2034	Farm Management, Production and Resource Economics	1:0:1
53	18AG2035	Principles of Food Sciences and Nutrition	2:0:0
54	18AG2036	Study Tour – II	0:0:1
55	18AG2037	Spices, Medicinal and Aromatic Crops	2:0:1
56	18AG2038	Precision Farming and Agro Informatics	2:0:1
		Agricultural Engineering	
1	18AT2001	Fluid Mechanics and Open Channel Hydraulics	3:0:1
2	18AT2002	Engineering Properties of Biological Materials and Food Quality	2:0:0
3	18AT2003	Post-Harvest Engineering of Cereals, Pulses and oilseeds	2:0:0
4	18AT2004	Farm Machinery and Equipment-I	2:0:1
5	18AT2005	Tractor Systems and Controls	2:0:0
6	18AT2006	Farm Machinery and Equipment-II	2:0:1
7	18AT2007	Field Operation and Maintenance of Tractors and Farm Machinery	0:0:2
8	18AT2008	Post-Harvest Engineering of Horticultural Crops	2:0:0
9	18AT2009	Soil and Water Conservation Engineering	2:0:1
10	18AT2010	Fundamentals of Renewable Energy Sources	2:0:0
11	18AT2011	Extension Methodology and Transfer of Technology	2:0:0
12	18AT2012	Dairy and Food Engineering	2:0:1
13	18AT2013	Storage Structures and Packaging Technology	2:0:1
14	18AT2014	Agricultural Waste and By-products utilization	2:0:0
15	18AT2015	Ground water, Wells and Pumps	2:0:1
16	18AT2016	Water Harvesting and Soil Conservation Structures	2:0:1
17	18AT2017	Bio Energy Systems: Design and Applications	2:0:1
18	18AT2018	Irrigation and Drainage Engineering	2:0:1
19	18AT2019	Micro Irrigation	2:0:1
20	18AT2020	Process Engineering for Spices and Plantation Crops	2:0:0
21	18AT2021	Application of RS and GIS in Agriculture	2:0:0
22	18AT2022	Process Equipment Design	2:0:0
23	18AT2023	Development of Processed Products	2:0:0
24	18AT2024	Farm Machinery Design and Production	2:0:0
25	18AT2025	Tractor Design and Testing	2:0:0
26	18AT2026	Mechanics of Tillage and Traction	2:0:0
27	18AT2027	Ergonomics, Human Engineering and Safety in Agricultural Machinery	2:0:0
28	18AT2028	Drip and Sprinkler Irrigation-Design and Installation	0:0:10
29	18AT2029	Watershed Management-Concept and Strategies	0:0:10
30	18AT2030	Precision Farming in the Semi-arid and Humid Tropical Zones	0:0:10

31	18AT2031	Minor Irrigation and Command Area Development	0:0:10
32	18AT2032	Landscape Irrigation Design and Management	0:0:10
33	18AT2033	Agro-Industry Design and Management	0:0:10
34	18AT2034	Farm Machinery and Power	1:0:1
35	18AT2035	Soil and Water Conservation	1:0:1
36	18AT2036	Skill Development Training-I (Student READY)	0:0:5
37	18AT2037	10-Weeks Industrial Attachment/Internship(Student READY)	0:0:10
38	18AT2038	10-Weeks Experiential Learning On campus (Student READY)	0:0:10
39	18AT2039	Skill Development Training-II (Student READY)	0:0:5
40	18AT2040	Educational Tour	0:0:2
41	18AT2041	Project Planning and Report Writing	0:0:10
42	18AT2042	Renewable Energy and Green Technology	1:0:1
43	18AT2043	Protected Cultivation and Secondary Agriculture	1:0:1
44	18AT2044	Water Quality and Management Measures	2:0:0
45	18AT2045	Basics of MATLAB Programming	2:0:0
46	18AT2046	Farm Mechanization – Field Study	0:0:10
47	18AT2047	Testing of Farm Machinery and Equipments	0:0:10
48	18AT2048	Value Addition of Indigenous Fruits and Vegetables	0:0:10
49	18AT2049	Applications of Solar and Wind Energy in Agriculture	3:0:0
50	18AT2050	Skill Development Training-I (Student READY)	0:0:5
51	18AT2051	10-Weeks Industrial Attachment/Internship(Student READY)	0:0:10
52	18AT2052	10-Weeks Experiential Learning On campus (Student READY)	0:0:10
53	18AT2053	Skill Development Training-II (Student READY)	0:0:5

18AG1001 FUNDAMENTALS OF AGRONOMY

Credits : 3:0:1

Course objectives

- To have a general understanding of the Agronomy, seasons, crop and its classification
- To appraise the students about crops, planting/sowing, growth and factors influencing growth and crop nutrition and its general management
- To study the impact of weeds on crop production and its management

Course outcomes

- Basics of crop characteristics and its classifications understood
- Fundamentals of growth, factors influencing and its relationship with nutrients studied
- Scientific knowledge on weeds its impacts on crop growth and the Integrated weed management studied

Theory

Agronomy and its scope, seeds and sowing, tillage and tilling, crop density and geometry, crop and its classifications, Crop nutrition, manures and fertilizers, nutrient use efficiency, Weeds- importance, classification, crop weed competition, concepts of weed management, principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, study of agro-climatic zones of India, Identification of weeds in crops, Methods of herbicide and fertilizer application, Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements- reversible plough, one way plough, harrow, leveler, seed drill.

References

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8. Sankaran, S. and Subbiah Mudaliar, V.T. 1991.Principles of Agronomy. Bangalore, Printing & Publishing Co., Bangalore

18AG1002 AGRICULTURAL HERITAGE

Credits : 1:0:0

Course objectives

- To have a general understanding of importance of the agriculture and agriculture resources in India
- To study the agriculture heritage of India from ancient to modern period
- To study the indigenous traditional knowledge in agriculture and the crop voyage in India and the world
- To study the gender perspective and task of farm women and women's empowerment and self-help groups

Course outcomes

- Studied the agriculture resources and development of agriculture in India from ancient to modern period
- Indigenous traditional knowledge (ITK) and its uses in agriculture learned
- Gained knowledge on gender issues in agriculture, women empowerment and self help groups

Theory

Agriculture scope; Importance of agriculture and agricultural resources available in India; Origin of agriculture- branches of agriculture- agricultural systems in the world-Crop significance and classifications; Green revolution and its impact- National agriculture setup in India; ICAR and SAUs- Current scenario of Indian agriculture; Indian agricultural concerns and future prospects-CGAIR and international institutions. Introduction of Indian agricultural heritage; Ancient agricultural practices, Relevance of heritage to present day agriculture; Past and present status of agriculture and farmers in society; Journey of Indian agriculture and its development from past to modern era; Natural calamities and famines- Plant production and protection through indigenous traditional knowledge; Crop voyage in India and world; Introduction to gender perspectives in agriculture- gender concepts- multiples roles of women- Women in agriculture- multifaceted roles and tasks of farm women- gender, poverty and livelihoods. Gender equity and strategies for rural women's empowerment- self- help groups. Farm mechanization and women- Occupational health hazards- Women friendly agricultural technology- Ergonomical approaches- Technological options

References

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2. Ahmed, S. 2004. Gender Issues in Agricultural and Rural Livelihoods-Vol. I M.S. Swaminathan Research Foundation, Chennai and Kerala Agricultural University, Thrissur.

3. Commonwealth Secretariat.1996. Women and Natural Resource Management: A Manual for the Asian Region. Gender and Youth Affairs Division, London.
4. Noor Mohammed.1992. Origin, diffusion and development of agriculture. In: Noor Mohammed (ed.), New Dimensions in Agricultural Geography: Vol.1.Historical Dimensions of agriculture. Concept publishing Co., New Delhi. Pp 29-75.
5. Handbook of agriculture, 2012, ICAR, New Delhi

18AG1003 INTRODUCTORY AGRICULTURAL METEOROLOGY AND CLIMATE CHANGE

Credits : 1:0:1

Course Objectives:

- To understand the role of agricultural meteorology in crop production
- To learn climatic factors and their measurements
- To study the fundamentals of climate change
- To provide knowledge on the effect of climate change on crop production

Course Outcome:

- Agro-climatic factors understood
- Measurement and estimation techniques for climatic parameters learned
- Fundamentals of climate change studied
- Effect of climate change on crop production understood

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

References

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2. Varshneya, M.C. and Balakrishna Pillai, B. 2003. Textbook of Agricultural Meteorology. ICAR, New Delhi
3. Venketaraman, S. and Krishnan, A. 1992. Crops and weather. ICAR, New Delhi

4. Sachati, A.K. 1985. Agricultural Meteorology — Instruction-cum-practical manual, NCERT, New Delhi
5. Mavi, HS, 1986. Introduction of Agrometeorolgy. Oxford & IBH Publishing Co. New Delhi

18AG1004 FUNDAMENTALS OF PLANT BIOCHEMISTRY

Credits : 2:0:1

Course Objectives:

- The students will know, why the broad spectrum of biochemistry is important in medicine, agriculture, pharmaceuticals, and ethics;
- To educate on the importance of Biomolecules with structure classification and function.
- To understand about the generation and storage of metabolic energy

Course Outcome:

- Knowledge about developments in biochemistry Cell structure, water and major molecules of life.
- Understand overall aspects of the integration of metabolic processes;
- Basics of carbohydrates proteins enzymes vitamins nucleic acids minerals and lipids will be understood

Theory

A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Carbohydrate chemistry: structure, classification, functions (mono, di and polysaccharides) isomerism and mutarotation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Protein chemistry: classifications and functions. Classification, structure, function and properties of amino acids. Essential and non-essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Digestion and absorption of lipids. Lipid auto oxidation. Significance of Omega-3 and Omega-6 fatty acids. Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones- chemistry and function. Structure and functions of fat and water soluble vitamins. Vitamins – classification- functions. Minerals – classification – functions. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Protein synthesis. Energy changes in chemical reactions, reversible and irreversible reactions in metabolism.

Practical

Preparation of normal solution of acid and base, buffers and reagents. Qualitative determination of carbohydrates, proteins and lipids. Estimation of total nitrogen and total protein. Estimation of carbohydrates in foods. Determination of specific gravity of oil. Extraction and estimation of total lipids in seeds. Determination of saponification value, iodine value and free fatty acid value.

References

1. Jain, L. 2001. Fundamentals of Biochemistry, 5th Edition, S. Chand & company, New Delhi.
2. Lehninger, A. 1984. Principles of Biochemistry, Published by CBS publishers and Distributors, New Delhi.
3. Thayumanavan. B, Krishnaveni S, Parvathi K. Biochemistry for Agricultural Sciences, Galgotia Publications, New Delhi.
4. Verma, S.K. 2000 A Text Book of Plant Physiology and Biochemistry, S. Chand & company, New Delhi-110055.

18AG1005 AGRICULTURAL MICROBIOLOGY

Credits : 2:0:1

Course Objectives:

- To learn about the structure of microbes.
- To have a general understanding on soil microbiology.
- To study the beneficial use of microorganisms.

Course Outcomes:

- Structure of microbes studied.
- Action of microbes in soils understood.
- Beneficial use of microbes learned.

Theory

Introduction. Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste.

Practical

- Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture.
- Methods of sterilization.
- Nutritional media and their preparations.
- Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.
- Methods of isolation and purification of microbial cultures.
- Isolation of *Rhizobium* from legume root nodule.
- Isolation of *Azotobacter* from soil.
- Isolation of *Azospirillum* from roots. Isolation of BGA.
- Staining and microscopic examination of microbes.

References

1. Alexander, M. 1985. Introduction to Soil Microbiology .John Wiley & Sons , New York.
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 1993. Microbiology. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Stanier, R.Y., Ingraham, Wheelis, M.G. and Paintor, P.R. 1986. The Microbiology World. Prentice Hall, New Jersey.
4. Subba Rao, N.S. 1999 .Biofertilizers in Agricultural and Agroforestry .Oxford & IBH New Delhi
5. <http://www.agrimoon.com/agriculture-icar-ecourse-pdf-book/> TNAU (ICAR)

18AG1006 RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY

Credits : 2:0:0

Course objectives

- To get an idea of sociological behaviour of rural population
- To familiarize the functions of rural society social stratification and social changes
- To understand the behaviour pattern and theories of motivation

Course outcomes

- Students learnt the rural society and their behaviour pattern
- Students gained the practical knowledge of functions of social institution
- Familiarize the concept of agricultural extension practices

Theory

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

References

1. Desai, A.R. 2003. *Rural sociology in India*. Popular Prakashan, Bombay.
2. Partha Sarathi De., 2012. *Rural Sociology*. Pearson Education, New Delhi
3. Samanta, R.K. and Arora, S.K. (Eds) . 1997. *An introduction to Sociology*. Kitab Mahal. S.D., Pvt. Ltd. Allahabad

18AG1007 IRRIGATION WATER MANAGEMENT

Credits : 1:0:1

Course objectives

- To understand the water resources of the country and state
- To study the soil water plant relationship and soil moisture constant
- To introduce the concept of water requirement of crops and irrigation management

Course outcomes

- Students learnt the estimation of the irrigation requirement by various methods
- Students gained the practical knowledge of implementation of surface, pressurized and micro irrigation
- Familiarize the concept of water productivity and principles of drainage

Theory

Irrigation: definition and objectives. Role of water in soil and plants-Water resources and irrigation development in India and Tamil Nadu. Soil-plant-water-relationships. Soil moisture constants. Evapotranspiration, potential evapo-transpiration and consumptive use, Reference crop evapotranspiration (ET_o)- Crop co-efficient (K_c)- K_c values for different crops. Main empirical methods of calculation of ET_o- Effective rainfall, Water requirement of crops- Factors affecting water requirement of crops- Methods of determining water requirement-effective rainfall- Scheduling irrigation based on various approaches – Methods of irrigation. Surface, subsurface, overhead and micro irrigations including sprinkler, drip and bubbler irrigation. Irrigation efficiency- Water productivity and water use efficiency- Agronomic techniques to improve water productivity- Conjunctive use of water- irrigation water quality criteria and its management. Water management of principal crops of Tamil Nadu. Agricultural drainage-causes of water logging and types of drainage.

Practical

Determination of bulk density by field method; Determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; Determination of field capacity by field method; Determination of permanent wilting point; Measurement of irrigation water through flumes and weirs; Calculation of irrigation water requirement (Problems); Determination of infiltration rate; Demonstration of furrow method of irrigation; Demonstration of check basin and basin method of irrigation; Operation of sprinkler, drip and common micro irrigation systems; Visit to a water management research station

References

1. Michael, A.M. 2007. *Irrigation Theory and Practice* (2nd Ed.). Vikas Publishing House Pvt. Ltd., New Delhi.
2. Sankara Reddi, G.H. and Yellamananda Reddy, T. 2003. *Efficient Use of Irrigation Water*. Kalyani Publishers, Ludhiana.

3. Lenka, D. 2005. Irrigation and Drainage (3rd Ed.). Kalyani Publishers, Ludhiana.

18AG1008 PRINCIPLES OF GENETICS AND CYTOGENETICS

Credits: 2:0:1

Course Objectives:

- To study mendelian concepts of heredity
- To impart knowledge on linkage and crossing over
- To make the student understand gene structure and function
- To study about genetic disorders

Course Outcome:

- Students will understand the concept of Mendelian principles
- Overview of Linkage and crossing over
- Understand the Gene structure and function

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; special types of chromosomes. Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example. Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications, Use of haploids, dihaploids and doubled haploids in Genetics. Mutation, classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance. Genetic disorders. Nature, structure & replication of genetic material. Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope. Study of cell structure. Mitosis and Meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and cross-over analysis (through two point test cross and three point test cross data). Study on sex linked inheritance in *Drosophila*. Study of models on DNA and RNA structures.

References

1. Gardner, J., Simmons, M. J. and Snustad, D. P. 2009. Principles of Genetics (8th Ed.). Wiley India Pvt. Ltd., New Delhi.
2. Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
3. Singh, B.D. 2000. Fundamentals of Genetics (6th Ed.). Kalyani Publishers, Ludhiana
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5. <http://www.agrimoon.com/agriculture-icar-ecourse-pdf-book/> TNAU (ICAR)

18AG1009 FUNDAMENTALS OF CROP PHYSIOLOGY

Credits : 2:0:1

Course Objectives:

- To introduce the students to crop physiology and biochemical changes during crop development.
- To impart knowledge on transport system in plants, photosynthesis and respiration
- To understand growth and growth characteristics

Course Outcome:

- Knowledge gained on different aspects of crop physiology.

- Learned detailed understanding of the physiological mechanisms involved in the uptake and transport of water and the translocation of food by plants.
- Study growth pattern of plants and growth parameters in crop production.

Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; Photosynthesis: Light and Dark reactions, C₃, C₄ and CAM plants; Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism: Fatty acid synthesis and Breakdown; Plant growth regulators: Physiological roles and agricultural uses, Physiological aspects of growth and development of major crops: Growth analysis, Role of Physiological growth parameters in crop productivity.

Practical

Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, Separation of photosynthetic pigments through paper chromatography, Rate of transpiration, photosynthesis, respiration, tissue test for mineral nutrients, estimation of relative water content, Measurement of photosynthetic CO₂ assimilation by Infra Red Gas Analyser (IRGA).

References

1. Jain, J.K. 2007. Fundamentals of plant physiology, S.Chand & Company Ltd., New Delhi.
2. Pandey, S. N. and B. K.Sinha, 2006. Plant Physiology. Vikas Publishing House Private Limited, New Delhi.
3. Ray Noggle, G. and Fritz, G. J., 1991. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Taiz. L. and Zeiger. E., 2006. Plant Physiology. Publishers: Sinauer Associates, Inc., Massachusetts, USA.

18AG1010 FUNDAMENTALS OF PLANT PATHOLOGY

Credits : 2:0:1

Course Objectives:

- To impart knowledge on plant diseases and plant pathogens
- To make the student understand the classification and life cycle of plant pathogens
- To learn basics of plant disease management

Course Outcome:

- Able to know and differentiate different plant pathogens and disease caused by them
- Knowledge on pathogen characteristics, reproduction, resting structures and transmission will be imparted
- Chemical nature, mode of action of different fungicide, Physical and bio-control measures will be studied

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes. Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes. Bacteria and mollicutes: general morphological characters. Basic methods of classification and

reproduction. Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites. Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, Anguina, Radopholus etc.) Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants. Epidemiology: Factors affecting disease development. Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

References

1. Agrios, G.N. 2005. Plant Pathology. (5 th Ed.). Elsevier Academic Press. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 2014. Introductory Mycology (4thEd.). Wiley India Pvt Ltd. Jayaraman, J. and Verma, J. P. 2002. Fundamentals of Plant Bacteriology (Reprint, 2015). Kalyani publishers, New Delhi
2. Ravichandra, N.G. 2013. Fundamentals of Plant Pathology. PHILearning Pvt Ltd. 639p.
3. Walkey, D. G. 1991. Applied Plant Virology (2nd Ed.). Springer.
4. Webster, J. and Weber, R. W. S. 2007. Introduction to Fungi. (3 rd Ed.). Cambridge University press.
5. Thorne, G. 1971. Principles of Nematology, McGraw Hill Book Co., New York, London.

18AG1011 FUNDAMENTALS OF ENTOMOLOGY

Credits : 2:0:1

Course Objectives:

- To impart knowledge on morphology, anatomy and physiology of insects
- To make the student understand insect ecology and different IPM techniques
- To learn the insect systematics

Course Outcome:

- Insect body parts, organ systems - their structure, functions and modifications will be understood
- Knowledge on factors influencing pest occurrence and different (physical, chemical and biological) control measures will be gained
- Orders and families of Agricultural importance pests and their characteristics will be studied

Theory

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance.

Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control importance, hazards and limitations. Recent methods of pest control, repellents, anti feed ants, hormones, attractants, gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes.

Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophoridae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae. Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

References

1. Gullan, P. J. and Cranston, P. S. 2014. The insects: an outline of entomology. (8th Ed.) Wiley Blackwell
2. Metcalf, C. L. and Flint, W. P. 1973. Destructive and Useful Insects. Tata Mc Graw Hill Publishing Co. New Delhi.
3. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. 1979. General and Applied Entomology. Tata Mc Graw Hill Publishing Co. New Delhi.
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5. Pant, N. C. and Ghai, S. 1973. Insects Physiology and Anatomy. I CAR. New Delhi, 332 p. 6. Richards, O. W. and Davies, R. G. 1977. Imms General Textbook of Entomology Vol. I Chapman and Hall, London.
6. Richards, O. W. and Davies, R. G. 1977. Imms General Textbook of Entomology. Vol. II Chapman and Hall, London.
7. Snodgrass, R. E. 1935. Principles of Insect Morphology. Tata Mc Graw Hill Publishing Co. New Delhi.

18AG1012 FUNDAMENTALS OF AGRICULTURAL ECONOMICS

Credits : 2:0:0

Course objectives

- To orient the students about the principles of economics and to get an idea of macro and micro economics
- To expose the basic theories of economics
- To understand the concept of agricultural economics and its relation with other subjects

Course outcomes

- Students learnt the concept of basic economic theories
- Familiarize the function of market and its impact on agricultural production
- Gained knowledge on agricultural finance and the role of banks and other credit agencies

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. *Demand:* meaning, law of demand, schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. *Laws of returns:* Law of variable proportions and law of returns to scale. *Cost:* concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, schedule, supply curve, determinants of supply, elasticity of supply. Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break even points. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. *National income:* Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socioeconomic determinants, current policies and programmes on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy. Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure. *Tax:* meaning, direct and indirect taxes, agricultural taxation, GST. *Economic systems:* Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

References

1. Dewett, K.K. 2005. Modern Economic Theory. S. Chand, New Delhi.
2. Dewett, K.K. and Verma. 2004. Elementary Economic Theory, S. Chand, New Delhi
3. Jhingam, M.L. 2001. Micro Economic Theory. Konark publishers, New Delhi
4. Reddy, S., Raghuram, P., Neelakantan, T.V. and Bhavani D. I. 2004. Agricultural Economics. Oxford and IBH Publishers, New Delhi.

18AG1013 FUNDAMENTALS OF SOIL SCIENCE

Credits : 2:0:1

Course Objectives:

- To impart knowledge about the soil forming process.
- To learn about physical properties of soil.
- To have a general understanding on soil chemical properties reactions.
- To study the impacts of soil pollution and the remediation measures.

Course Outcomes:

- Knowledge gained about the soil forming process.
- Physical properties of soil studied.
- Various soil chemical properties and reactions understood.
- Impact of soil pollution and remediation measures learnt.

Theory

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention, movement and availability; Soil air, composition, gaseous exchange, problem and plant growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids- inorganic and organic; silicate clays: constitution and properties; sources of charge; ion exchange, cation exchange capacity, base saturation; soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Study of soil profile in field. Study of soil sampling tools, collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Determination of soil colour. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

References

1. Biswas, T.D. and Mukherjee, S.K. 1987. Text Book of Soil Science. Tata McGraw Hill Publishing Co., New Delhi
2. Black, C.A. 1982. Methods of Soil Analysis, Part I ASA, Madison, USA.
3. Brady, N.C. 1990 Nature and Properties of Soils. 10th Edn, Macmillan Publishing Co. Inc., New York
4. Das, D.K. 1997. Introductory Soil Science. Kalyani Publishers New Delhi

18AG1014 FUNDAMENTALS OF AGRICULTURAL EXTENSION EDUCATION

Credits : 2:0:1

Course Objective:

- The course is intended to orient the students with the concept of extension education and its importance in Agriculture development
- To expose the students with various rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis
- To make the students learn about the new innovations being brought into the Agricultural Extension in India

- To learn about the new trends in agriculture extension

Course Outcome:

- Students learned the concepts of agricultural extension and rural development programs.
- New innovations in the area of agricultural extension in India understood
- Gained practical knowledge on watershed development and self-help groups
- New trends in agriculture extension learned

Theory

Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning- Meaning, Process, Principles and Steps in Programme Development. Extension systems in India: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP, etc.). New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc. Rural Development: concept, meaning, definition; various rural development programmes launched by Govt. of India. Community Dev.- meaning, definition, concept & principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; handling and use of audio visual equipments and digital camera and LCD projector; preparation and use of AV aids, preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA and other development departments at district level; visit to NGO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; exposure to mass media: visit to community radio and television studio for understanding the process of programme production; script writing, writing for print and electronic media, developing script for radio and television.

References

1. De, Dipak. 2011. *A handbook of Extension education*. JV Publishing House, Jodhpur
2. Van Den Ban, A.W. and Hawkins, H.S. 1998. *Agricultural Extension* (2nd Ed). New Delhi, CBS Publishers and Distributors.
3. Vasanth Kumar, J. 2007. *New Dimensions and approaches in Extension Pluralism for Rural Development*. J.V. Publishing House, Jodhpur.
4. www.planning commission.nic.in
5. www.agricoop.nic.in
6. www.rural.nic.in

18AG1015 INTRODUCTION TO AGRICULTURE AND HORTICULTURE

Credits 2:0:0

Course Objectives:

- To introduce the scope of agriculture to engineering students
- To impart knowledge on soil-water-plant relationship

- To familiarize with plant growth and fertilizer application and irrigation

Course Outcome:

- Basics of agriculture science learned
- Soil-water-plant relationship learned
- Different stages of plant growth and application of fertilizers studied

Theory

Orientation to agriculture and agricultural engineering. Soils: Nature and origin of soil; soil forming rocks and minerals, soil forming processes, important soil physical properties and their importance. Ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility. Soil reaction – acid, saline and sodic soils. Agronomy: Definition and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. Principles of tillage, tillage and its characteristics. Soil water plant relationship and water requirement of crops. Soil fertility and its management, integrated nutrient management. Bio-fertilizers and vermicomposting. Weeds and their control, integrated weed management. Crop rotation, cropping systems, relay cropping and mixed cropping. Sustainable agriculture, integrated farming system, precision farming, organic farming and good agricultural practices. Horticulture: Scope and Importance of horticultural and vegetable crops - Divisions - Soil and climatic requirements for fruits, vegetables and floriculture crops, Criteria for site selection, layout, planting methods in orchard establishment - Nursery raising - Macro propagation, Micro propagation methods and its applications in horticulture - Plant growing structures and Special horticultural practices- Fertilizer application, fertigation and irrigation methods- Garden tools and management of orchard - Extraction and storage of vegetables seeds.

Reference books

1. Sharma, Rakesh Kumar et. Al., Basics of Agriculture for Engineers, Daya Publishing House, 2014
2. Gajendra Singh Tomar, Agronomy: Basic and Applied, Satish Serial Publishing House, 2010
3. Bose, T.K and S.K. Mitra. 1990. Fruits, Tropical and Subtropical. Naya Prakash, 206 Bidthan saran, Calcutta.
4. Brady, Nyle C. 1988. The nature and properties of Soils. Eurasia Publishing House Pvt Ltd, New Delhi.
5. Das, P.C. 1993. Vegetable Crops of India. Kalyani Publishers, New Delhi.
6. De, G.C. 1989. Fundamentals of Agronomy. Oxford & IBH Publishing Co Pvt Ltd, New Delhi.

18AG1016 INTRODUCTORY AGRO FORESTRY

Credits : 1:0:1

Course objectives

- To study the importance of forest and agroforestry systems in sustaining the land productivity
- To understand the crop tree interactions in different types of agroforestry systems
- To get an idea of the productive and protective functions of agroforestry

Course outcome

- Students learnt about the concepts of agroforestry practiced in various agro ecosystems
- Basic understanding of the multipurpose trees in agroforestry systems
- Beneficial effects of agro forestry such as nitrogen fixing, soil conservation, litter dynamics and nutrient cycles will be studied

Theory

Introduction – definitions of basic terms related to forestry, importance and objectives of silviculture, types of forests-salient features of Indian Forest Policies. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations- tree

stand management. Agroforestry – definition and concepts Agroforestry systems and practices- different agroforestry systems prevalent in the country and Tamil Nadu, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, plantation crop combinations, home gardens. Multi purpose trees in agroforestry, characteristics- Under storey components and diversification potentials- Component interactions- above ground and below ground interactions. Productive and protective functions- Nitrogen fixation- Soil conservation- Litter dynamics and nutrient cycling – Carbon sequestration and climate change mitigation - Social forestry- concept and importance, practices in different agro ecosystems

Practical

Identification of tree-species. Diameter measurements using calipers and tape. Height measurement of standing trees by shadow method, single pole method and hypsometer. Nursery lay out, seed sowing, vegetative propagation techniques. Different agroforestry systems like sAgroforestry systems, Silvopastoral systems, Agroforestry systems and their interactions

References

1. Puri, S and Panwar, P. (ed.). 2007. Agroforestry Systems and Practices. New India Publishing Agency, New Delhi, 643p
2. Gupta, R.K. 1993. Multipurpose Trees for Agroforestry and Wasteland Utilization. Oxford and IBH, 562p
3. Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publications, Dordrecht, The Netherlands, 499p

18AG1017 WEED MANAGEMENT

Credits : 1:0:1

Course Objectives:

- To identify the weed species present in different agro ecosystems
- To study the different weed control methods
- Learn about herbicides and its formulations and integrated weed management

Course Outcomes:

- Students will be familiarised about the weed species and weed classification
- Different weed control methods and management will be studied.
- Different herbicides and its formulations and integrated weed management will be understood.

Theory

Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicides and selectivity. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with agro-chemicals and their application. Integration of herbicides with non-chemical methods of weed management. Herbicide Resistance and its management.

Practical

Techniques of weed preservation. Weed identification and their losses study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and agrochemicals study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipments. Calculations of herbicide doses and weed control efficiency and weed index.

References

1. Jaganathan, R. and R. Jayakumar. 2003. Weed Science Principles, Kalyani Publishers, New Delhi.
2. Gupta, O. P. 1998. Modern Weed Management. Agro Botanica Bikaner, India.
3. Rao, V.S. 2000. Principles of Weed science. Oxford & IBH Publishing Co. New Delhi.

18AG1018 PRODUCTION TECHNOLOGY FOR VEGETABLE, FRUIT AND PLANTATION CROPS

Credits: 2:0:1

Course Objective:

1. To impart knowledge on basic cultural practices of Vegetables, Fruits and Plantation Crops.
2. To insist on modern techniques to increase the yield and production.
3. To learn about the economic estimation of commercial Horticultural crops.

Course Outcome:

1. The student gains a thorough knowledge on basic production technology.
2. Familiarize on basic pruning and training techniques of fruits and plantation crops.
3. Acquaintance on commercial oriented cultural practices.

Theory

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and subtropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle. Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production. History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micropropagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation. Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of

growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona. Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

References

1. S. Thamburaj, 2014. Text book of vegetable, tuber crops and Spices. ICAR, New Delhi
2. B.R.Choudhary, 2009. A Text book on production technology of vegetables. Kalyani Publishers. Ludhiana.
3. T.K.Bose, 2002. Vegetable Crops. Nayaprakash. Kolkata..
4. M.S.Ladaniya, 2013. Citrus Fruits. Elsevier, India post Ltd.
5. Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. Tropical and Sub-Tropical-Vol-I. Nayaudyog-Kolkata
6. Chundawat, B.S., 1990. Arid fruit culture. Oxford and IBH, New Delhi.
7. Chadha, K.L. (ICAR) 2002, 2001. Hand book of Horticulture. ICAR, New Delhi.
8. Symmonds, 1996. Banana. II Edn. Longman, London.
9. Radha T and Mathew L., 2007. Fruit crops. New India Publishing Agency.
10. W S Dhillon, 2013. Fruit Production in India. Narendra Publishing House, New Delhi

18AG2001 PRINCIPLES OF PLANT BREEDING

Credits : 2:0:1

Course Objectives:

- To impart knowledge on genetic diversity, inheritance and variation in crops
- To make the student understand different breeding methods in asexually propagated, self and cross pollinated crops
- To learn IPR, patenting, Plant Breeders and Farmers Rights

Course Outcome:

- Origin and diversity of different crops, components of inheritance and variations will be understood
- Students will be able to apply different breeding techniques for crop improvement
- Gain knowledge on IPR, patenting, Plant Breeders and Farmers Rights followed

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility- genetic consequences, cultivar options. Domestication, Acclimatization and Introduction; Centres of origin/ diversity, components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept. Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement Schemes- Ear to row method, Modified Ear to Row, recurrent selection schemes; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and

hybridization; Maintenance of breeding records and data collection; Wide hybridization and prebreeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and cross pollinated crops. Emasculation and hybridization techniques in self & cross pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

Reference books

1. Acquaah, G. 2007. Principles of Plant Genetics & Breeding. Blackwell Publishing Co., New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Gupta, S. K. 2005. Practical Plant Breeding. Agribios, Jodhpur.
5. Roy, D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House Pvt. Ltd., New Delhi.
6. Sharma, J. R. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing Co. Pvt. Ltd., New Delhi.
7. Simmonds, N.W. and Smartt, J. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
8. Singh, B. D. 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana.
9. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
10. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.
11. Singh, P. and Narayanam, S. S. 2009. Biometrical Techniques in Plant Breeding (4th Ed.). Kalyani Publishers, Ludhiana.
12. Singh, S. and Pawar, I. S. 2006. Genetic Bases and Methods of Plant Breeding. CBS Publishers, New Delhi.

18AG2002 CROP PRODUCTION TECHNOLOGY - I (KHARIF CROPS)

Credits : 1:0:1

Course Objectives:

- To provide foundational understanding of kharif crop production
- To learn the economic importance of kharif crops
- To provide knowledge on cultural practices of kharif crops

Course Outcome:

- Economic importance of kharif crops understood
- Basic management for kharif crops production learned
- Cultural practices for crop production studied

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses-pigeonpea, mungbean and urdbean; oilseeds- groundnut, and soybean; fibre crops- cotton & jute; forage crops-sorghum, cowpea, cluster bean and napier.

Practical

Rice nursery preparation, transplanting of rice, sowing of soybean, pigeonpea and mungbean. maize, groundnut and cotton, effect of seed size on germination and seedling vigour of kharif season crops, effect

of sowing depth on germination of kharif crops, identification of weeds in kharif season crops, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of kharif season crops, study of crop varieties and important agronomic experiments at experimental farm. study of forage experiments, morphological description of kharif season crops, visit to research centres of related crops.

Reference

1. Prasad, R. (ed.). 2001. *Field Crop Production*. ICAR, New Delhi
2. Pal, M., Deka, J. and Rai, R.K. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill Pub., New Delhi
3. Singh, C., Singh, P., and Singh, R. 2003. *Modern Techniques of Raising Field Crops* (2nd ed.). Oxford & IBH, New Delhi.

18AG2003 AGRICULTURAL FINANCE AND COOPERATION

Credits : 2:0:1

Course objectives

- To get an idea of credit needs and its role in Indian agriculture
- To familiarize the sources of agriculture finance
- To learn the cooperative movement its principles and its significance in agricultural community

Course outcome

- Students learn the functions of banks and types of banks, role of RBI and NABARD in agricultural finance
- Students learn the credit availability and functions of different types of cooperative societies in the state
- Basic understanding of financial statements, balance sheets and income statements

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent developments in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms – SWOT analysis.

Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

Practical

Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business – A case study. Preparation and analysis of balance sheet – A case study. Preparation and analysis of income statement – A case study. Appraisal of a loan proposal – A case study. Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products.

References

1. Reddy, S. and Ram, P.R. 2005. *Agricultural Finance and Management*. Oxford and IBH, Publishers, New Delhi.

2. Reddy, S., Raghuram, P., Neelakantan, T.V and Bhavani, D.I. 2004. *Agricultural Economics*. Oxford and IBH Publishers, New Delhi.
3. RBI: <https://www.rbi.org.in>
4. NABARD: <https://www.nabard.org>
5. World Bank: <http://www.worldbank.org>
6. ADB: <http://www.adb.org>
7. Lead Bank: <http://www.canarabank.com>

18AG2004 PRODUCTION TECHNOLOGY OF VEGETABLES

Credits 1:0:1

Course Objectives

- To understand the importance of vegetable cultivation
- To learn about production technology of tropical vegetable crops
- To impart knowledge about constraints in vegetable cultivation

Course Outcome

At the end of this course, the students will be able to

- Understand the role of vegetables in human nutrition and national economy
- Learn about production techniques of tropical vegetable crops, importance and layout of kitchen gardening, and management of physiological disorders
- Explain and analyze the constraints and economics in vegetable production

Theory

Importance of vegetables in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of important vegetables (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas; Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic; Root crops such as Carrot, Raddish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables).

Practical

Identification of vegetable crops and their seeds. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables. Fertilizers applications. Harvesting & preparation for market. Economics of vegetable cultivation.

References

1. Gopalakrishnan, T.R., 2007. "Vegetable Crops" New India publishing agency, New Delhi.
2. James S. Shoemaker and Thomas Smith., 2006. "Culture of Veg., Growing" Asiatic.
3. Neeraj Pratap Singh . 2005. "Basic concepts of vegetable science", International Book distributing co., New Delhi.
4. Pranab Hazra, A. Chattopadhyay, K. Karmakar and S. Dutta. 2010. "Modern technology in vegetable production" New India Publishing Agency, New Delhi.
5. Vishnu Swarup, 2006. Vegetable science and technology in India. Kalyani publishers, New Delhi.
6. Uma Shankar Singh, 2008. "Indian vegetables", Anmol publications Pvt., Ltd., New Delhi.

18AG2005 LIVESTOCK AND POULTRY MANAGEMENT

Credits 3:0:1

Course objectives

- To understand the importance of farm animals
- To study characters of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry
- To study the management of farm animals, its nutrient requirement and its housing

Course outcome

- Understood the importance of farm animals and its influence in rural economy
- Gained knowledge on characteristics of indigenous and exotic breeds of cattle, goat, buffalo, swine and poultry
- Practical knowledge on management of farm animals, its nutrient requirement and its housing

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipments. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

Reference books

1. Banerjee, G.C. 2010. The Text Book of Animal Husbandry. Oxford Book Company, Calcutta.
2. Sastry, N.S.R., Thomas, C.K. 2005. Livestock Production Management. Kalyani Publishers, Ludhiana
3. Watson, J.A.S. and Mills, W.J. (2005). Farm animals and their Management.

18AG2006 AGRI INFORMATICS**Credit 1:0:1****Course Objectives**

- To impart knowledge on application of IT in agriculture using computerized models
- To learn about precision agriculture using geospatial technology
- To learn, design and develop Decision Support Systems (DSS) and soil information for agricultural applications

Course Outcome

At the end of this course, the students will be able to

- Understand use of information, communication and technology (ICT) in agriculture
- Demonstrate use of GIS and GPS systems in precision agriculture
- Apply and develop computerized models to understand plant growth process

Theory

E-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture,

Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Practical

Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

Text Books

1. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
2. Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.

References

1. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
2. Adams, C.R. K.M. Band ford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Daryaganj, New Delhi.
3. Lyn. Malone, Anita M. Palmer, Christine L. Vioghat Jach Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
4. David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA

18AG2007 FARMING SYSTEMS AND SUSTAINABLE AGRICULTURE

Credits 1:0:0

Course Objectives

- To understand the concept of sustainable agriculture
- To understand the scope and maximize efficiency by developing integrated farming systems
- To impart knowledge on different farming systems and its interaction in farm productivity

Course Outcome

At the end of this course, the students will be able to

- Differentiate the different types of farming and cropping systems
- Relate between sustainable agriculture and conventional agriculture
- Understand different concept and components of integrated farming systems management

Theory

Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

Reference Books

1. Palaniappan S. P and Sivaraman, 1996, Cropping systems in the tropics principles and management, New Age International Pvt. Ltd., New Delhi
2. Jayanthi C, Devasenapathy and C. Vennila, 2007, Farming System Principles and Practices, Satish Serial Publishing House, New Delhi
3. S. C. Panda, 2003, Cropping and Farming Systems, Agrobios Publishers, Jodhpur.

18AG2008 CROP PRODUCTION TECHNOLOGY-II (RABI CROPS)

Credits : 1:0:1

Course Objectives:

- To provide foundational understanding of *Rabi* crop production
- To learn the economic importance of *Rabi* crops
- To study the basic management for *Rabi* crop production
- To provide knowledge on cultural practices of *Rabi* crops

Course Outcome:

- Economic importance of *Rabi* crops understood
- Basic management for *Rabi* crops production learnt
- Cultural practices for crop production studied

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals –wheat and barley, pulses-chickpea, lentil, peas, oilseeds-rape seed, mustard and sunflower; sugar crops-sugarcane; medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops-berseem, lucerne and oat.

Practical

Sowing methods of wheat and sugarcane, identification of weeds in *rabiseason* crops, study of morphological characteristics of *rabicrops*, study of yield contributing characters of *rabiseason* crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of *rabicrops* at experimental farms. Study of *rabiforage* experiments, oil extraction of medicinal crops, visit to research stations of related crops.

Reference

1. Das, P.C. 1997. Oilseed Crops of India, Kalyani Publishers., New Delhi
2. Yadav, D.S. 1992. Pulse Crops. Kalyani Publishers.,
3. Prasad, R. (ed.). 2001. Field Crop Production. ICAR, New Delhi
4. Balasuramaniyan, P. and Palaniappan, S.P. 2003. Principles and Practices of Agronomy. Agrobios(India)

18AG2009 PRODUCTION TECHNOLOGY FOR ORNAMENTAL CROPS AND LANDSCAPING

Credits: 1:0:1

Objective

- To educate students on production technology of cut flowers, ornamental crops and turf management.
- To study the Landscape use of trees, shrubs and climbers
- Exposing the students to different styles of landscape gardening.
- To know about harvesting and post-harvest handling of flower crops.

Outcomes:

- Familiarized with the production technology of cut flowers, ornamental crops and turf management.
- Landscape use of trees, shrubs and climbers were studied
- Learnt about the various styles of gardening.
- Got familiarized with the harvesting and post-harvest handling of flower crops.

Theory

Importance and scope of ornamental crops, cut flowers, foliage plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, liliun and orchids under protected conditions and gladiolus, tuberose,

chrysanthemum under open conditions. Various styles of gardening. Lawn establishment and maintenance. Landscaping designs for different environments. Package of practices for loose flowers like marigold and jasmine under open conditions. Package of practices for cut flowers like rose and carnation. Processing and value addition in ornamental crops.

Practical

Identification of Ornamental plants. Identification of foliage plants and cut flowers. Nursery bed preparation, seed sowing and transplanting. Training and pruning of Ornamental plants. Planning and layout of garden. Bed preparation and planting of cut flowers. Lawn establishment and maintenance. Protected structures – care and maintenance. Intercultural operations in flowers and foliage plants. Harvesting and post harvest handling of cut and loose flowers. Visit to commercial flower and landscaping units.

References books:

1. G.S. Randhawa, 1998. Floriculture in India, Allied Publishers Pvt. Ltd., New Delhi
2. Desh Raj, 2014. Floriculture at a glance, Kalyani Publishers, New Delhi

18AG2010 PRODUCTION TECHNOLOGY OF FRUITS AND PLANTATION CROPS

Credits 1:0:1

Course Objectives

- To study the scope and scenario of fruit and plantation cultivation
- To educate them about the production technology of fruit and plantation crops
- To impart the knowledge about the advanced fruit and plantation cultivation and its constraints.

Course Outcome

At the end of this course, the students will be able to

- Understand the scope and importance of fruit and plantation crop production
- Learn cultivation aspects of major fruit and plantation crops
- Learn about biotic and abiotic constraints (pests, diseases and physiological disorders) of fruit and plantation crop production
- Learn cultivation aspects of major fruit and plantation crops

Theory

Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, sapota, apple, pear, peach, walnut, almond and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, Important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

References:

1. Ben Pike, 2011. The Fruit Tree Handbook, UIT Cambridge Ltd
2. Peter. K.V., 2011. Plantation crops, NBT publication
3. Kumar.N., 2017. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, CBS Publishers; 2nd edition
4. Ponnuswami.V., 2015. Text Book on Fruit & Plantation Crops – 2015, Narendra Publishing House
5. Tyagi. S.K., 2010. Handbook of Fruit Crops, Jain Brothers.

18AG2011 PRINCIPLES OF SEED TECHNOLOGY

Credits : 1:0:1

Course objectives

- To learn about seed, grain and seed quality
- To introduce the concepts of seed certification, seed Act and seed test
- To have the knowledge about the foundation and certified seed production of cereals, pulses, oilseeds, fodder and vegetable crops

Course outcome

- Students learnt the seed production techniques
- Students enabled in identifying seed structure and morphology, physical characteristics of seed and biochemical tests
- Students capacitated in seed sampling, seed storage and seed marketing

Theory

Seed and seed technology: introduction, definition, its importance in increasing agricultural production. Difference between seed and grain and concept of seed quality. Deterioration causes of crop varieties and their control. Maintenance of genetic purity during seed production. Genetic and agronomic principles of seed production. Different classes of seed and truthfully labeled seed. Seed certification, phases of certification. Procedure for seed certification, field inspection. Foundation and certified seed production of important cereals (Rice, wheat and maize), pulses (Cowpea, mung, urd, pigeonpea, field bean and soybean), oilseeds (Sesame, coconut, sunflower, groundnut), fodder (Guinea grass, napier grass and lucern), and vegetables (Bhindi, tomato, brinjal, chillies and cucurbitaceous vegetables). Seed Act and Seed Act enforcement. Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency, Central and State Seed Testing Laboratories. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983 and Seed Bill 2004 and other issues related to seed quality regulation. Varietal identification through electrophoresis and biochemical tests. Synthetic seeds and terminator gene technology. Detection of genetically modified crops. Transgene contamination in non-GM crops, GM crops and organic seed production. Physiological and harvestable maturity. Seed dormancy, internal and external factors affecting dormancy in seeds. Seed drying. Seed processing and their steps. Seed treatment, its importance, methods of application. Seed packing. Seed sampling and testing. Seed storage: general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies. Participatory seed production and seed village concept

Practical

Varietal identification through seed structure and morphology, physical characteristics of seed and biochemical tests. Germination test in field and horticultural crops. Quick viability test of field and horticultural crops. Seedling vigour tests. Seed sampling principles and procedures; Physical purity analysis of field and horticultural crops. Genetic purity test: Grow out test and electrophoresis. Roguing, field inspection and preparation of field inspection report. Seed production in major cereals, pulses, oilseeds and vegetable crops. Visit to seed testing laboratories, farms and seed processing plants.

References

1. Khare and Bhale , 2014. Seed Technology, Scientific Publishers, New Delhi.
2. Sharma, J.P. 2011. Quality Seed Production of Vegetable Crops Technological Interventions, Volume 2: Crop Specific Aspect. Kalyani Publishers, Ludhiana.
3. Agrawal, P.K. and Dadlani, M. 1995. Techniques in seed science and technology. South Asian Publishers, New Delhi.
4. Agrawal, R.L. 1996. Seed Technology. Oxford & IBH Publication Co., New Delhi.

18AG2012 PROBLEMATIC SOILS AND THEIR MANAGEMENT

Credits : 2:0:0

Course Objectives:

- To learn about soil health quality and irrigation water quality parameters.
- To have a general understanding on reclamation and management of problem soils.
- To provide knowledge on Remote sensing, GIS and land use pattern.

Course Outcomes:

- Soil quality and irrigation water quality parameters learnt.
- Reclamation and management of problem soils understood.
- Remote sensing , GIS and bioremediation procedures studied.
- Land use pattern studied.

Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Their categorization based on properties. Reclamation and management of Saline and sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils. Irrigation water – quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils. Multipurpose tree species, bio remediation through MPTs of soils, land capability and classification, land suitability classification. Problematic soils under different Agro-ecosystems.

References

1. Donahu, L. R., Miller, W. R. and Shickuluna, 1977. Soils. Prentice Hall of India Pvt. Ltd., New Delhi Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI New Delhi, 2002
2. William F. Bleam Soil and Environmental Chemistry (Second Edition) UW Madison, Department of Soil Science, Madison, WI, United States. Elsevier Inc. (Available Online)
3. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. 1982. Saline Alkali Soils of India, ICAR, New Delhi.
4. Biswas, T.D. and Mukharjee, S.K. 2001. Text Book of Soil Science, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

18AG2013 AGRICULTURAL MARKETING, TRADE AND PRICES

Credits : 2:0:1

Course objectives

- To understand the concept of market structure and its classification
- To study the theories of demand and supply of agricultural produce in market oriented economy
- To learn the grading, packing, branding, labelling (AGMARK) of agricultural produce

Course outcomes

- Learnt the role of Government in agricultural marketing and price stability in agricultural produce
- General awareness of trade, present status of GATT, WTO, agreement on agriculture (AOA)
- Will be studying the role of public sector institutions namely CWC, SWC, FCI, CACP and DMI

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri-commodities: nature and Concept of risk and uncertainty in agriculture production, nature and sources of risks and its management strategies, Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources - Positive and negative externalities in agriculture. Inefficiency and

welfare loss, solutions-Important issues in economics and management of common property resources of land, water, pasture and forest resources Farm inventory- Methods of valuation of farm assets-Depreciation-Meaning-Methods of computation of depreciation Classification of farming-Type of farming – Specialization, Diversification, Mixed farming,Dry farming and Ranching – Systems of farming -co-operative farming, Capitalistic farming, collective farming, State farming and Peasant farming determinants of demand and supply of farm products, producer's surplus – meaning and its types,marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; Marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark);Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel;number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India;Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Marketing Management-product life cycle (PLC) and competitive strategies: Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

Practical

Plotting and study of demand and supplyMarket curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

References

1. Philip, K. 2004. Marketing Management. Prentice Hall, New Delhi.
2. Philip, K. 2004. Principles of Marketing. Prentice Hall, New Delhi.
3. Acharya, S.S. and Agarwal, N.L.1994. Agricultural Prices and Policy. Oxford and IBH, New Delhi.
4. Alagumani ,T., Chinnaiyan, P. and Elangovan, S.1998. Agricultural Management . Publishers K9 International, Madurai.

18AG2014 INTRODUCTION TO BIOTECHNOLOGY

Credits : 1:0:1

Course Objectives:

- To expose the students to the basic scientific evidence and technical aspects of the different disciplines of biotechnology in agriculture (mainly for plants and crops).
- To understand the concepts and techniques in biotechnology
- Upon completion of this course the student should recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant DNA technology.

Course Outcome:

- Knowledge gained on different aspects of biotechnology
- Study the current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic
- Learned the general principles of generating transgenic plants, animals and microbes

Theory

Biotechnology: Introduction to Biotechnology –scope and importance in agriculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering-Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology– vaccines. Transgenic plants and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle

of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting.

Practical

Study of structure of prokaryote and eukaryote Cells. Study on Model of protein Synthesis, Study of models rDNA Technology, Cell Culture, Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophoresis, ELISA, DNA sequence analysis and comparison.

References

1. Brown T A. 2002. Genomes 2. 2nd ed. New york:Wiley-Liss.
2. Prave P, Faust U &Sittig W. 1987. Fundamentals of Biotechnology. VCH Verlagsgesellschaft.
3. Chawla, H.S.2012. Introduction to plant biotechnology. IBH publishing Co.
4. Singh, B. D. 2013. Molecular biology, genetic engineering and applications of biotechnology. Kalyani Publishers.

18AG2015 ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

Credits : 2:0:1

Course Objectives:

- To know about the natural resources- Renewable and Non renewable
- To study about the Ecosystem, Biodiversity , Environmental pollution and conservation aspects
- To learn about the Natural and Man- made Disasters and their Management

Course Outcomes:

- Learnt about the natural resources- Renewable and Non renewable
- Studied about the Ecosystem, Biodiversity , Environmental pollution and conservation aspects
- Learnt about the Natural and Man- made Disasters and their Management

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, waterlogging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. •

Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act.

Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

References

1. Ahluwalia, V.K and Malhotra, S. Environmental Science. 2006. Ane Books Pvt. Ltd. India
2. Banjerji, S.K. 1993. Environmental Chemistry. Prentice Hall of India Pvt. Ltd, New Delhi
3. Gupta, A.K. 2007. Methods in Environmental Analysis Water, Soil and Air. 2nd Edn. Published by AGROBIOS(India) Jodpur
4. Katyal, K. and Satake, M. 1990. Environmental Pollution. 2nd Edn. Anmol Publishers, New Delhi
5. Loomis, R.S and Corner, D.J. 1992. Crop Ecology, Productivity and Management in Agricultural Systems. Cambridge University Press Pandey, S.N and Misra, S.P. 2011 Environment and Ecology. Ane Books Pvt. Ltd. India

18AG2016 MEDICINAL, SPICES AND AROMATIC PLANTS

Credits: 1:0:1

Course Objectives

- To learn about the scope and importance of medicinal, spices and aromatic plants
- To understand production technology of medicinal, spices and aromatic plants
- To study various processes, essential oils and their uses of medicinal, spices and aromatic plants

Course Outcome

At the end of this course, the students will be able to

- Remember the scope and importance of medicinal, spices and aromatic plants
- Understand production technology of medicinal, spices and aromatic plants
- Explain about the various processes, essential oil and their uses of medicinal, spices and aromatic plants

Theory

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Storage techniques of essential oils. Crops: Clove, Nutmeg, Cinnamon and Tamarind Origin and distribution – Area and production – Composition and uses – Soil and climate – varieties – propagation – planting – irrigation - nutrition management - weed control – mulching - mixed cropping, intercropping, multi-tier cropping - cover cropping - training and pruning practices - role of growth regulators- harvest and yield- GAP – constraint Production technology of important medicinal plants like ashwagandha, periwinkle, isabgol and palmarosa, ocimum. Aromatic Plants:, lavender, patchouli and other species relevant to the local conditions. Processing and value addition in MAPs produce.

Practical

Collection of medicinal, spices and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Text books

1. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
2. Jitendra Singh. 2008. Spices and Plantation Crops. Aavishkar Publishers, Distributors, Jaipur.

18AG2017 STUDY TOUR – I

Credits 0:0:1

Course Objectives

- To familiarize students about other agricultural research institutions in the state
- To learn about ongoing agricultural research and extension programs

Course Outcome

At the end of this course, the students will be able to

- Gain practical knowledge of agricultural crops grown in the different agro climatic zones in Tamil Nadu
- Learn the social, cultural differences in the society of various agricultural zones
- Find out differences in soil types and cropping systems in Tamil Nadu

Course Content:

The study tour programme is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour programme, full attendance is mandatory for a pass as per the ICAR regulations.

The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

18AG2018 PRACTICAL CROP PRODUCTION-I (KHARIF CROPS)

Credits 0:0:2

Course Objectives

- To impart practical training on cultivation practices of Kharif crops
- To learn about the phenological phases and its significance of each phase in crop production
- To be able to calculate/estimate yield and other parameters influencing crop yield

Course Outcome

At the end of this course, the students will be able to

- Gain knowledge about cultivation practices of Kharif crops
- Identify problems in Kharif cultivation and to offer solutions
- Construct a balance sheet showing cost of cultivation and net income generated

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students. Important kharif crops like rice and maize will be raised.

Reference Books

1. Rajendra Prasad, 2006, Text book of field crops, ICAR, New Delhi
2. Mukund Joshi, 2015, Text book of field crops, PHI Learning Private Ltd., New Delhi
3. Chidida Singh, 1997, Modern techniques of raising field crops, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi

18AG2019 CROP IMPROVEMENT – I (*kharif*)

Credits: 1:0:1

Course Objectives

- To learn about diversity, inheritance and genetic variations present in *kharif* crops
- To learn the different breeding methods in asexually propagated, self and cross pollinated *kharif* crops
- To familiarize with hybrid seed production techniques and ideotype concepts in *kharif* crops

Course Outcome

At the end of this course, the students will be able to

- Remember the origin and diversity of different crops, components of inheritance and various crop improvement techniques
- Understand different breeding techniques for the genetic improvement in *kharif* crops
- Evaluate the adaptability, stability, Quality parameters, biotic and abiotic stress of various *kharif* crops
- Utilize hybrid seed production techniques in farming of kharif crops

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeonpea, etc. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species; viz., Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Sesame, Caster, Cotton, Cowpea, Brinjal, Okra and Cucurbitaceous crops. Maintenance breeding of different *kharif* crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

References

1. Agarwal.P.K, 2017. Principles of Seed Technology. South Asian Publishers, New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Simmonds, N.W. and Smartt, J. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
5. Singh, B. D., 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana
6. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
7. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.

18AG2020 MANURES, FERTILIZERS AND SOIL FERTILITY MANAGEMENT

Credits 2:0:1

Course Objectives

- To understand the properties and composition of organic manures and chemical fertilizers
- To learn about the mechanism of nutrient transport in plant and soil, plant nutrient deficiency and toxicity symptoms.
- To study about soil chemistry, soil fertility testing and plant nutrient analysis

Course Outcome

At the end of this course, the students will be able to

- Remember the properties of manures, fertilizers and soil amendments
- Understand the concept of soil fertility and plant nutrition, chemistry of nutrients in soil, manuring, Integrated Nutrient Management and fertilizer recommendation practices
- Evaluate the fertility of soil and plant nutrient content

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management. Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order.

History of soil fertility and plant nutrition. criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability

to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions.

Practical

Introduction of analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of soil organic carbon, Estimation of alkaline hydrolysable N in soils. Estimation of soil extractable P in soils. Estimation of exchangeable K; Ca and Mg in soils . Estimation of soil extractable S in soils.. Estimation of DTPA extractable Zn in soils. Estimation of N in plants. Estimation of P in plants. Estimation of K in plants. Estimation of S in plants.

Reference Books

1. Millar, C. E. 1955. Soil Fertility. John Wiley Publishers, New York
2. John L. Havlin, Samuel L. Tisdale, Werner L. Nelson and James D. Beaton. 2016. Soil Fertility and Fertilizers. Pearson Publishers. London.
3. Yawalkar KS, Agarwal JP and Bokde S .2002. Manures and Fertilisers (Ninth Edition).. Agri-Horticultural Publishing House, Nagpur- 440010, India.
4. Parker and Harold.J.1991. Environmental handbook for fertilizer and agrichemical dealers. Tennessee Valley Authority, National Fertilizer and Environmental Research Center.
5. A.K. Kolay.2007.Manures and Fertilizers. Atlantic Publishers & Distributors (P) Ltd., Chennai

18AG2021 DISEASES OF FIELD & HORTICULTURAL CROPS AND THEIR MANAGEMENT - I

Credits: 2:0:1

Course Objectives

- To learn about the various diseases of field and horticultural crops and their casual organisms
- To learn the symptoms associated with the disease and to understand the etiology and disease cycle
- To know different integrated practices to be followed for the management of plant pathogens

At the end of this course, the students will be able to

- Recall various plant pathological terms and basic concepts of important plant diseases
- Explain the disease symptoms of various plant diseases of field and horticultural crops
- Interpret the host pathogen interaction on disease development in field and horticultural crops
- Determine the prevalence, epidemiology and factors affecting disease development
- Apply integrated management practices to control diseases of field and horticultural crops

Theory

Symptoms, etiology, disease cycle and management of major diseases of following crops:Field Crops: Rice: blast, brown spot, bacterial blight, sheath blight, false smut, khaira and tungro;Maize: stalk rots, downy mildew, leaf spots; Sorghum: smuts, grain mold and anthracnose,Bajra :downy mildew and ergot; Groundnut: early and late leaf spots, wilt. Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Finger millet: Blast and leaf spot; black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Castor: Phytophthora blight;Tobacco: black shank, black root rot and mosaic. Horticultural Crops: Guava: wilt and anthracnose; Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top;Papaya: foot rot, leaf curl and mosaic, Pomegranate: bacterial blight; Cruciferous vegetables: Alternaria leaf spot and 98 black rot; Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight; Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic; Okra: Yellow Vein Mosaic; Beans: anthracnose and bacterial

blight; Ginger: soft rot; Colocasia: Phytophthora blight; Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Note: Students should submit 50 pressed and well mounted specimens.

References

1. Arjunan.G. Karthikeyan, G, Dinakaran ,D. Raguchander,T. 1999 Diseases of horticultural Crops, AE Publications, Coimbatore.
2. Das Gupta M.K. and Mandel W.C.1989. Post harvest pathogens of Perishables. Oxford and IBH Publishing Company, New Delhi.
3. Rangaswamy C.2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi.
4. Dasgupta, M.K. and Mandal, W.C. 1989. Post harvest pathology of perishables. Oxford IBH publishing Co., New Delhi.
5. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York.
6. Chaube H.S and Pandhir 2005. Crop diseases and their management .Prentice hall of India Pvt. Ltd. New Delhi
7. Gupta V.K and Paul V.S 2004. Fungi and Plant diseases. Kalyani Publishers .New Delhi
8. Mehrota, R.S. 1980. Plant Pathology, Tata Mc Grow Mill Pub. Co., New Delhi, Prakasam, V., Valluvaparidasan, V., Raguchander, T. and K.Prabakar. 1997. Field crop diseases, AE Publication, Coimbatore.
9. Singh, R.S .1993. Plant Diseases, Oxford & IBH Publication, New Delhi.

E.Books:

1. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York.
2. Rangasawmi ,G and Mahadevan, A. 1998. Diseases of crop Plants in India, Prentice Hall of India Pvt. Ltd., New Delhi

18AG2022 PRINCIPLES OF INTEGRATED PEST AND DISEASE MANAGEMENT

Credits: 2:0:1

Course Objectives

- To learn about the various categories of economically important pest and diseases
- To understand the principles and methods of detection and diagnosis of pest and diseases
- To learn about Integrated Pest and Disease Management practices

Course Outcome

At the end of this course, the students will be able to

- Relate and recall the important concepts and principles of Integrated pest and disease management
- Summarize and illustrate the important pest and diseases of various crops and formulate IPM strategies

Theory

Categories of insect pests and diseases, IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management. Survey surveillance and forecasting of Insect pest and diseases. Development and validation of IPM module. Implementation and impact of IPM (IPM module for Insect pest and disease. Safety issues in pesticide uses. Political, social

and legal implication of IPM. Case histories of important IPM programmes. Case histories of important IPM programmes.

Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of *Trichoderma*, *Pseudomonas*, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agroecosystem) dynamics of a selected insect pest and diseases. Plan & assess preventive strategies (IPM module) and decision making. crop monitoring attacked by insect, pest and diseases . Awareness campaign at farmers fields.

References

1. Agrios, G. N. 2008. Plant Pathology, 5th edition, Academic Press, New York.
2. Nene, Y.L. and Thapliyal, P.N. 1998. Fungicides in plant disease control. Oxford and IBH publishing Co. Ltd., New Delhi.
3. Chattopadhyay, S.G. 1998. Principles and procedure of plant protection, Oxford and IBH publishing Co. Ltd., New Delhi.
4. Narayanasamy, P. 1997. Plant pathogens detections and disease control. Oxford and IBH publishing Co. Ltd., New Delhi.
5. Narayanasamy, P. 2011. Microbial plant pathogens detections and disease diagnosis Vol. I. Springer publication.
6. Nagarajan 1983. Dynamics of plant disease. Allied publishers, New Delhi.
7. Dinakaran, D, Arjunan, G and Karthikeyan, G. 2003. Biological control of crop diseases
8. Prakasam, V., T. Raguchander and K. Prabakar, 2006. Applied Plant Pathology, A.E. publications, Coimbatore.
9. Cooke, B.M, Jones, D.G and Kaye, B. 2006. The Epidemiology of plant Diseases. Published by Springer, The Netherlands
10. Awasthi, V.B. 2007. *Agricultural Insect Pests and their Control*, Scientific publishers (India), Jodhpur, 267p. {ISBN:81-7233-491-5}
11. Dhaliwal, G.S. and Ramesh Arora. 2004. *Integrated pest management Concepts and Approaches*, Kalyani Publishers, Ludhiana, 427p. {ISBN:81-7663-904-4}
12. Regupathy, A. and R. Ayyasamy. 2013. *A Guide on Crop Pests*. Namrutha Publications, Chennai, 368 p. {ISBN:978-81-921477-1-0}
13. Srivastava, K.P. and G.S. Dhaliwal. 2011. *A text book of Applied Entomology*. Vol. II, Kalyani Publishers, Ludhiana. 368p. {ISBN:978-81-272-6752-0}

E- books

1. Agrios, G.N. 2005. Plant Pathology – (5th Edition). Academic Press, New York
2. Pal, K. K. and B. McSpadden Gardener, 2006. Biological Control of Plant Pathogens. *The Plant Health Instructor* DOI: 10.1094/PHI-A-2006-1117-02. APS Net
3. J.M. Waller, J.M. Lenné and S.J. Waller 2002. Plant Pathologist's Pocketbook 3rd Edition, CABI Publishing UK
4. Cooke, B.M, Jones, D.G and Kaye, B. 2006. The Epidemiology of plant Diseases. Published by Springer, The Netherlands

18AG2023 PESTS OF CROPS AND STORED GRAINS AND THEIR MANAGEMENT

Credit: 2:0:1

Course Objectives

- To learn about symptoms, damage and seasonal incidence of agricultural, horticultural and storage pests.
- To understand the fundamental principles and components of Insect Pest Management.
- To familiarize with the importance of storage pest and management strategies to avoid losses.

Course Outcome

At the end of this course, the students will be able to

- Remember morphology and taxonomic characteristics of insect pests affecting crops and stored grains
- Understand nature and type of damage by different arthropod pests in field, vegetable, fruit and plantation crops, ornamental crops, spices and condiments
- Analyze factors influencing pest occurrence, distribution and control measures
- Summarize factors affecting losses of stored grain, role of various factors in deterioration of grain and their management strategies

Theory

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice other important arthropod pests of various field crop, vegetable crop, fruit crop, plantation crops, ornamental crops, spices and condiments. Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; (d) Plantation, gardens, Narcotics, spices & condiments. Identification of insect pests and Mites associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides application technique. Fumigation of grain store / godown. Identification of rodents and rodent control operations in godowns. Identification of birds and bird control operations in godowns. Determination of moisture content of grain. Methods of grain sampling under storage condition. Visit to Indian Storage Management and Research Institute, Hapur and Quality Laboratory, Department of Food., Delhi. Visit to nearest FCI godowns.

References

1. Dhaliwal, G. S. and Ramesh Arora. 2014. Integrated Pest Management: Concepts and Approaches, Kalyani Publication, New Delhi.
2. Muthukrishnan, N., N. Ganapathy, R. Nalini and R. Rajendran. 2005. Pest Management in Horticultural Crops. New Madura Publishers, Madurai, 325 pages.
3. Ragupathy, A. and R. Ayyasamy. 2013. A Guide on crop pests. Namrutha Publications, Chennai, 368 pages.
4. Ranjeet Kumar. 2017. Insect pests of stored grain, Apple Academic press, Canada, 394 pages.

18AG2024 PRECISION FARMING

Credit 1:0:1

Course Objectives

- To learn about the scope and importance of precision farming
- To understand the role of GIS, GPS and drones in agriculture
- To familiarize with crop simulation models and their role in precision farming

Course Outcome

At the end of this course, the students will be able to

- Relate the use of GIS and GPS systems in drip installation and fertigation techniques
- Demonstrate use of Unmanned Aerial Vehicle (UMAV) to gather information
- Develop precision farming technology for important crops.

Theory

Precision farming - introduction - concept and importance; Tools - Role of GIS and GPS – Unmanned Aerial Vehicle (UMAV) - Mobile mapping system and its application in precision farming; Design - layout and installation of drip and fertigation; Site specific management (SSM) - geo-referencing and photometric correction; Sensors - information gathering and application; Crop simulation models - role in precision farming. Precision farming technology- crops -cotton - banana and tomato.

Practical

Estimation of material requirement for construction of greenhouse ; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques;; crop simulation models; Design - layout and installation of drip and fertigation techniques

Text Books

1. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
2. Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.

References

1. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
2. Adams, C.R. K.M. Band ford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Daryaganj, New Delhi.
3. Lyn. Malone, Anita M. Palmer, Christine L. Vloghat Jach Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
4. David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA

18AG2025 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT

Credit: 1:0:1

Course Objectives

- To explore agri-business opportunities and motivate towards the idea of entrepreneurship.
- To familiarize with project planning, monitoring and book keeping
- To impart leadership, managerial, and problem-solving skills in Agri-business management

Course Outcome

At the end of this course, the students will be able to

- Understand the scope of agri-business opportunities and idea of entrepreneurship.
- Demonstrate leadership and problem-solving skills
- Formulate business proposal and develop/plan financial strategy

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship

development, Impact of economic reforms on Agribusiness/ Agri-enterprises, Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for Agri entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing,

Visit to local rural enterprise engaged in agribusiness (Agri out-based based)

Visit to local rural enterprise engaged in agribusiness (Agri input based)

Art of raising fixed and working capital for the business -Interaction with bank managers funding entrepreneurs and agribusinesses.

Visit to entrepreneurship development institute and studying their promotional activities.

Reference Books

1. Entrepreneurship Development and Communication Skills, R. R. Chopra, P.S.Kapse, P.R.Deshmukh, Scientific Publishers (India).
2. Entrepreneurship Development and Management, R.K.Singal, S.K.Kataria & sons
3. Fundamentals of Entrepreneurship, H. Nandan, PHI publishers.
4. Entrepreneurship Development , Sangeeta Sharma, PHI Publishers.
5. Heady Earl O and Herald R. Jenson, 1954, Farm Management Economics. Prentice Hall, New Delhi
6. S.S. Johl, J.R. Kapur. 2006, Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi
7. Karan Singh and Kahlon A S. Economics of Farm Management in India. Theory and Practice. New Delhi.
8. Allied L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
9. Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.

18AG2026 INTELLECTUAL PROPERTY RIGHTS

Credits 1:0:0

Course Objectives

- To learn about individual rights to protect/patent inventions obtained in the process of projectwork.
- To know how to register inventions/designs, in India and abroad.
- To acquire knowledge and familiarize with patenting, copyright, trademark, designs and information Technology Act.

Course Outcome

At the end of this course, the students will be able to

- Understand acquiring the patent and copyright for their innovative work.
- Know how to register innovations and find out plagiarism which can be questioned legally.
- Achieve new innovative goals

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.

Types of Intellectual Property and legislations covering IPR in India: -Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent

claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database.

Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders' rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders.

Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

References:

1. V K Ahuja (2017) "Law Relating to Intellectual Property Rights"
2. R Radhakrishnan and S Balasubramanian (2008) "Intellectual Property Rights: Text and Cases"
3. Venkatraman, (2012) An Introduction to Intellectual Property Rights
4. Dr. B.L. Wadehra (2012) Law relating to Intellectual Property, Universal Law Publishing Co.

18AG2027 RAINFED AGRICULTURE AND WATERSHED MANAGEMENT

Credits 1:0:1

Course Objectives

- To study the systems of rainfed agriculture, land suitability, and farming practices in rainfed regions
- To study the adaptation and mitigation strategies, crop planning and crop management techniques
- To introduce the concepts, principles and components of water conservation and management

Course Outcome

At the end of this course, the students will be able to

- Understand sustainable agriculture practices under rainfed conditions
- Explain the various crop management techniques and the adaptation strategies for dry land agriculture
- Apply knowledge of different water conservation methods and effective water utilization through use of watershed management

Theory

Rainfed agriculture: Introduction, types, History of rainfed agriculture and watershed in India; Problems and prospects of rainfed agriculture in India ; Soil and climatic conditions prevalent in rainfed areas; Soil and water conservation techniques, Drought: types, effect of water deficit on physio-morphological characteristics of the plants, Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices, Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought period in the country, effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress. Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

Reference Books

1. Dhruva Narayana, 1993, Soil and Water Conservation Research in India, ICAR, New Delhi
2. Handbook of Agriculture, ICAR, New Delhi
3. Suresh, 2016, Soil and Water Conservation Engineering, New Delhi
4. <http://agriinfo.in/agronomy/42/>

5. Rayees Ahmed, 2017, Rainfed Agriculture and Watershed Management, Kushal Publications

18AG2028 PRACTICAL CROP PRODUCTION-II (RABI CROPS)

Credits 0:0:2

Course Objectives

- To impart practical training on cultivation practices of Rabi crops
- To identify the phenological phases and significance of each phase in crop production
- To be able to calculate/estimate yield and other parameters influencing crop yield

Course Outcome

At the end of this course, the students will be able to

- Gain the knowledge about cultivation practices of Rabi crops
- Identify problems relating to Rabi crop production and offer solutions
- Construct a balance sheet with inputs of cultivation costs and net income generated

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students. Important Rabi crops like sunflower will be raised.

Reference Books

1. Rajendra Prasad, 2006, Text book of field crops, ICAR, New Delhi
2. Mukund Joshi, 2015, Text book of field crops, PHI Learning Private Ltd., New Delhi
3. Chidda Singh, 1997, Modern techniques of raising field crops, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi

18AG2029 PRINCIPLES OF ORGANIC FARMING

Credits 1:0:1

Course Objectives

- To understand the historical, physio-chemical, biological and ecological basis of organic farming including various crop and soil management practices
- To study the agronomic practices and farming techniques of different crops and cropping systems under organic farming
- To familiarize with the concepts related to legislation, inspection, certification, and marketing of organic produce

Course Outcome

At the end of this course, the students will be able to

- Remember the concepts of organic farming
- Understand the crop management practices and technologies of various crops and cropping systems
- Apply the knowledge of standards, certification process and marketing strategy of organic farm products

Theory

Organic farming, principles and its scope in India; Initiatives taken by Government (central/ state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

Practical

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management; Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling.

Reference Books

1. Handbook of Agriculture, ICAR, New Delhi
2. S.P.Palaniappan and K. Annadurai. 2010, Organic farming theory and practices, Scientific Publishers
3. S.R. Reddy, 2017, Principles of Organic Farming, Kalyani Publishers

18AG2030 DISEASES OF FIELD & HORTICULTURAL CROPS AND THEIR MANAGEMENT - II

Credits: 1:0:1

Course Objectives

- To learn about major diseases of field and horticultural crops, their casual organism, etiology and disease cycle
- To be familiar with integrated farming practices to be followed for effective management of plant pathogens

Course Outcome

At the end of this course, the students will be able to

- Recall various plant pathological terms and basic concepts of important plant diseases
- Explain the disease symptoms of various plant diseases of field and horticultural crops
- Interpret the host pathogen interaction on disease development in field and horticultural crops
- Determine the prevalence, epidemiology and factors affecting disease development
- Apply the concept of integrated management practices to control diseases of field and horticultural crops

Theory

Symptoms, etiology, disease cycle and management of following diseases:

Field Crops:

Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and ear cockle; Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng; Sunflower: Sclerotinia stem rot and Alternaria blight; Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot; Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Cotton: anthracnose, vascular wilt, and black arm; Pea: downy mildew, powdery mildew and rust.

Horticultural Crops:

Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis; Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl. Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic; Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch, and Stemphylium blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leaf spot.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium. **Note:** Students should submit 50 pressed and well-mounted specimens.

References

1. Arjunan.G. Karthikeyan, G, Dinakaran ,D. Raguchander,T. 1999 Diseases of horticultural Crops, AE Publications, Coimbatore.

2. Das Gupta M.K. and Mandel W.C.1989. Post harvest pathogens of Perishables. Oxford and IBH Publishing Company, New Delhi.
3. Rangaswamy C.2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi.
4. Dasgupta, M.K. and Mandal, W.C. 1989. Post harvest pathology of perishables. Oxford IBH publishing Co., New Delhi.
5. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York.
6. Chaube H.S and Pandhir 2005. Crop diseases and their management .Prentice hall of India Pvt. Ltd. New Delhi
7. Gupta V.K and Paul V.S 2004. Fungi and Plant diseases. Kalyani Publishers .New Delhi
8. Mehrota, R.S. 1980. Plant Pathology, Tata Mc Grow Mill Pub. Co., New Delhi,
9. Prakasam, V., Valluvapardasan, V., Raguchander, T. and K.Prabakar. 1997. Field crop diseases, AE Publication, Coimbatore.
10. Singh, R.S .1993. Plant Diseases, Oxford & IBH Publication, New Delhi.

E.Books:

1. Agrios, G.N. 2008. Plant Pathology, Academic Press, New York
2. Rangaswamy, G and Mahadevan, A. 1998. Diseases of crop Plants in India, Prentice Hall of India Pvt. Ltd., New Delhi

18AG2031 POST HARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES

Credits 1:0:1

Course Objectives

- To learn about the extent of post-harvest losses of fruits and vegetables and the scope for food processing and preservation in Industry
- To familiarize with the different preservation techniques and value addition process of important fruits and vegetables
- To be aware of government schemes and laws regulating import and export of fresh fruits and vegetables

Course Outcome

At the end of this course, the students will be able to

- Remember the different post-harvest management of important fruits and vegetables
- Explain about the different value addition process of important fruits and vegetables
- Demonstrate knowledge about the different government schemes and laws in import and export

Theory

Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post harvest losses. Importance and scope of fruit and vegetable preservation industry in India, food pipe line, losses in post-harvest operations, unit operations in food processing. Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning – Concepts and Standards, packaging of products. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Applications of different types of packaging, containers for shelf life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Quality evaluation of products -- physico-chemical and sensory. Visit to processing unit/ industry. Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

References:

1. Verma, L. R. and Joshi, V. K. 2000. *Post Harvest Technology of Fruits and Vegetables*. Vol. I & II. Indus Publishing Co., New Delhi.
2. FAO - Training Manual No.17/2. 2007. *Prevention of post harvest food losses: Fruits, Vegetables and Root crops*. Daya Publishing House, Delhi.
3. Morris, T. N. 2006. *Principles of Fruit Preservation*. Biotech Books, Delhi. 81-7622-116-3.
4. Rathore N.S., G.K. Mathur., Chasta S.S. 2012. *Post-Harvest Management and Processing of Fruits and Vegetables*. The Energy And Resources Institute
5. Srivastava, R. P. & Sanjeev Kumar. 2002. *Fruits and vegetable Preservation – Principles and Practice*. International Book Distributing Co., Lucknow.

18AG2032 CROP IMPROVEMENT – II (*Rabi*)

Credits: 1:0:1

Course Objectives

- To learn about diversity, inheritance and genetic variations present in *rabi* crops
- To learn the different breeding methods in asexually propagated, self and cross pollinated *rabi* crops
- To familiarize with hybrid seed production techniques and ideotype concepts in *rabi* crops

Course Outcome

At the end of this course, the students will be able to

- Remember the origin and diversity of different crops, components of inheritance and various crop improvement techniques
- Understand different breeding techniques for the genetic improvement in *rabi* crops
- Evaluate the adaptability, stability, quality parameters, biotic and abiotic stress of various *rabi* crops
- Make use of hybrid seed production techniques in farming of *rabi* crops.

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fodder crops and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation; study of genetics of qualitative and quantitative characters; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology of *rabi* crops. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species namely Wheat, Chickpea, Field pea, Horse gram, Rapeseed, Mustard, Sunflower, Safflower, Potato, Berseem. Sugarcane, Tomato, Chilli, Onion; Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Rabi* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of

field experiments; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops

References

1. Agarwal.P.K, 2017. Principles of Seed Technology. South Asian Publishers, New Delhi.
2. Allard, R.W. 1981. Principles of Plant Breeding. John Wiley & Sons, New York.
3. Chopra, V. L. 2004. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Simmonds, N.W. and Smartt, J. 2014. Principles of Crop Improvement. Wiley India Pvt. Ltd., New Delhi.
5. Singh, B. D., 2014. Plant Breeding - Principles and Methods. Kalyani Publishers, Ludhiana
6. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, Ludhiana.
7. Singh, P. 2006. Essentials of Plant Breeding. Kalyani Publishers, Ludhiana.

18AG2033 MANAGEMENT OF BENEFICIAL INSECTS

Credits 1:0:1

Course Objectives

- To learn about beneficial insects like honeybee, silkworm, lac insect, biological control agents such as predators, parasites, parasitoids, and weed killers
- To be familiar with the rearing technique of mulberry silkworm and mulberry cultivation
- To be familiar with bee keeping techniques and mass culturing of predators and parasitoids

Course Outcome

At the end of this course, the students will be able to

- Understand role of beneficial insects like honeybees, silkworm and lac insect, predators, parasitoids, weed killers
- Remember identification of major parasitoids and predators commonly used in biological control
- Summarize various techniques for mass multiplication of natural enemies
- Apply innovative techniques in silkworm rearing and bee keeping to enhance silk and honey production

Theory

Importance of beneficial Insects, Beekeeping and pollinators, bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee. Role of pollinators in cross pollinated plants. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection.

Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac-products. Identification of major parasitoids and predators commonly being used in biological control. Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinator, weed killers and scavengers with their importance.

Practical

Honey bee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.

Reference Books

1. David B. Vasanthraj. Elements of Economic Entomology (1975)
2. K.N. Ragumoorthi, V. Balasubramani, M.R. Srinivasan, Natarajan. Insecta An Introduction. AE Publications (2014)
3. M. Madan Mohan Rao. An Introduction to Sericulture (2019), B.S. Publications

18AG2034 FARM MANAGEMENT, PRODUCTION & RESOURCE ECONOMICS

Credits: 1:0:1

Course Objectives

- To introduce concepts of farm management and production economics.
- To familiarize with economic principles/theory underlying resource allocation and decision-making process.
- To be able to apply economic principles to organization and management of businesses with emphasis on choice of optimal enterprise combinations to meet household goals
- To understand the role and factors influencing farm decision making.

Course Outcome

At the end of this course, the students will be able to

- Get in-depth knowledge about optimum use of capital, labour and land by recalling when to produce, where to produce and how to produce principles.
- Understand the management of the resources during production of crops, livestock and allied enterprises.
- Apply economic principles applicable in farm management

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms. Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labour income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies, Crop/livestock/machinery insurance –weather-based crop insurance, features, determinants of compensation. Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources. Positive and negative externalities in agriculture, Inefficiency and welfare loss, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India.

References

1. Raju, V.T. and Rao, D.V.S, (2014) Economics of Farm Production and Management"
2. Dewett, K.K. (2005). Modern Economic Theory. S. Chand, New Delhi.
3. Sharma . et. al., (2014) Practicals in Agricultural Economics, Daya Publishing House,

4. Chavan, U.D. et. al., (2015) Key Notes on Agricultural Economics, Business Management and Statistics (PB), Daya Publishing House

18AG2035 PRINCIPLES OF FOOD SCIENCE AND NUTRITION

Credit 2:0:0

Course Objectives

- To understand the basic concepts of food science, food chemistry and food microbiology
- To familiarize with the principles and methods of food processing and microbial food spoilers
- To understand effects of malnutrition and nutritional disorders
- To be able to plan a balanced/modified diet

Course Outcome

At the end of this course, the students will be able to

- Enumerate and describe food composition and food chemistry
- Analyze the methods to control microbes and to preserve food
- Design balance/modified diet to meet consumer needs.

Theory

Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.); Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions); Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.); Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/ modified diets, Menu planning, New trends in food science and nutrition.

Text books

1. Coultate.T.P 'Food- The chemistry of its components", 2nd edition.Royal Society ,London 1992.
2. Sivasanker, B. Food processing and preservation", prentice Hall of India Pvt. Ltd.New Delhi, ISBN 9788120320864, 2002
3. Frazier W.C.and D.C Westhoff, Food Microbiology", 4th Editiobn .,McGraw- Hill Book Co., Newyork-2008

18AG2036 STUDY TOUR – II

Credits 0:0:1

Course Objectives

- To be familiar with various agricultural institutions/ Research Stations/ Colleges in South India
- To be familiar with the ongoing agricultural research and extension programmes in various Agricultural Universities/ Institutions/ Colleges of South India

Course Outcome

At the end of this course, the students will be able to

- Gain practical knowledge about agricultural crops in the different agro-climatic zones in South India
- Learn social, cultural aspects of different agricultural zones
- Identify different soil types and cropping systems of South India

Course Content:

The study tour programme is of one week, during this period various Agricultural Research Stations, Institutions or Collages will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour programme, full attendance is mandatory for a pass as per the ICAR regulations.

The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

18AG2037 SPICES, MEDICINAL AND AROMATIC CROPS

Credits : 2:0:1

Course Objectives

- To teach scope and importance of Spices, medicinal and aromatic crops
- To impart knowledge on production technology of Spices, medicinal and aromatic plants
- To impart knowledge on various processes, essential oil and their uses of Spices, medicinal and aromatic plants

Course Outcome

- Scope and importance of Spices, medicinal and aromatic crops learnt
- Production technology of Spices, medicinal and aromatic plants studied
- Gain practical knowledge various processes, essential oil and their uses of Spices, medicinal and aromatic plants

Theory

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Storage techniques of essential oils. Crops: Clove, Nutmeg, Cinnamon and Tamarind Origin and distribution – Area and production – Composition and uses – Soil and climate –varieties – propagation – planting – irrigation - nutrition management - weed control – mulching - mixed cropping, intercropping, multi-tier cropping - cover cropping - training and pruning practices - role of growth regulators- harvest and yield- GAP –Organic production of Tree Spices- post harvest technologies – processing storage – value added products –organic production – constraintProduction technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Aromatic Plants: Citronella grass, lavender, geranium, patchouli, occimum and other species relevant to the local conditions. Processing and value addition in MAPs produce.

Practical

Collection of Spices, medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Text books

3. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
4. Jitendra Singh. 2008. Spices and Plantation Crops. Aavishkar Publishers, Distributors, Jaipur.

18AG2038 PRECISION FARMING AND AGRO INFORMATICS

Credit 2:0:1

Course Objectives:

- To impart knowledge in precision farming
- To impart knowledge in Hi-tech precision farming.
- To study precision farming techniques in agriculture.
- To impart knowledge in agro informatics
- To study on ICT in agriculture

Course Outcome:

At the end of this course, the students will be able to

- Understand drip installation and fertigation
- Understand precision farming techniques.
- Understand precision farming technology of important crops.
- Understand information, communication and technology (ICT) in agriculture

Theory

Precision farming - introduction - concept and importance; Tools - Role of GIS and GPS – Un Manned Aerial Vehicle (UMAV) - Mobile mapping system and its application in precision farming; Design - layout and installation of drip and fertigation; Site specific management (SSM) - geo-referencing and photometric correction; Sensors - information gathering and application; Crop simulation models - role in precision farming. Precision farming technology- crops -cotton - banana and tomato.

E-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Practical

Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

Text Books

1. Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
2. Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.

References

1. Handbook of Agricultural Engineering. 2016. ICAR, New Delhi.
2. Adams, C.R. K.M. Band ford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Daryaganj, New Delhi.
3. Lyn. Malone, Anita M. Palmer, Christine L. Vloghat Jach Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
4. David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA

18AT2001 FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS

Credits 3:0:1

Objectives

- To understand the basic principles, fundamental concepts and theories of fluid mechanics
- To impart knowledge on static, kinematics and dynamic aspects of fluids
- To learn the losses occurring in fluid flow and flow measurements

Outcomes

- The students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium.
- They will also gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.
- The students will be able to apply their knowledge on design and measurement of irrigation channels

Theory

Properties of fluids, Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon; Laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices, Flow through Mouthpieces, Notches, Weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers.

Practical

1. Verification of Bernoulli's theorem
2. Measurement of discharge with a venturimeter
3. Measurement of velocity with a pilot tube
4. Determination of coefficient of discharge of rectangular weir
5. Determination of coefficient of discharge of triangular weir
6. Determination of coefficient of discharge of trapezoidal weir
7. Determination of hydraulic coefficient of orifices
8. Experiment on broad crested weir
9. Determination of head losses in pipes
10. Experiments on open channels
11. Determination of roughness coefficients of open channels
12. Measurement of velocity and pressure profiles in open channels

Text Books

1. Bansal, R.K., A text book of Fluid Mechanics and Hydraulic Machinery, Laxmi Publications (P) Ltd., New Delhi, 2002.
2. P M and Seth S.M.1973. Hydraulics and Fluid Mechanics. Standard Book House, Delhi.
3. Khurmi, R .S. 1970. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines S. Chand & Company Limited, New Delhi.

Reference Books

1. Chow V T 1983. Open Channel Hydraulics. McGraw Hill Book Co., New Delhi.
2. LalJagadish 1985. Fluid Mechanics and Hydraulics. Metropolitan Book Co.Pvt. Ltd., New Delhi.

18AT2002 ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS AND FOOD QUALITY

Credits 2:0:0

Objectives

- To acquaint and equip the students with different engineering properties of biological materials.
- To learn the flow behavior of food materials.
- To impart knowledge on the application in design of food processing equipments.

Outcomes

- The students will get a basic knowledge of the various properties of solid and liquid food materials.
- They will also gain the knowledge in addressing problems in the bio material conveying systems.
- The students will be able to apply their knowledge on design equipments.

Theory

Classification and importance of engineering properties of Agricultural produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties; Co-efficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheoplectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures

Text Books

1. Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers , New York.
2. Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.
3. Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.

Reference Books

1. Mohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York.
2. Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.

18AT2003 POST-HARVEST ENGINEERING OF CEREALS, PULSES AND OILSEEDS

Credits 2:0:0

Objectives

- To equip the students with various post harvest techniques of food materials.
- To acquire basic concept of various unit operation in processing.
- To impart knowledge on the processing of a wide range of food products.

Outcomes

- The students will get a basic knowledge on post harvest techniques material handling equipments.
- They will also gain the knowledge in addressing problems in post harvest engineering of food grains.
- The students will be able to apply their knowledge on selection of equipments for various unit operations.

Theory

Milling of rice- Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.

Text Books

1. Chakraverty, A. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.
3. Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.

Reference Books

1. Dash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
2. Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi
3. Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London
4. McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill.
5. Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.

18AT2004 FARM MACHINERY AND EQUIPMENT-I

Credits 2:0:1

Objectives

- To expose the students to farm mechanization benefits and constraints.
- To equip the students in the identification of components of implements.
- To impart knowledge on the working principles of farm equipments, tillage implements.

Outcomes

- The students will be able to understand the mechanization in agricultural farms.
- The students will gain knowledge on the various equipment used in the farm for different field operations.
- The students will be able to apply their knowledge on selection of equipments for various operations.

Theory

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills. Introduction to planters, bed-planters and other planting equipment. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Materials used in

construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines.

Practical

1. Familiarization with different farm implements and tools.
2. Study of hitching systems.
3. Problems on machinery management.
4. Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements.
5. Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments.
6. Study of transplanters – paddy, vegetable, etc.
7. Identification of materials of construction in agricultural machinery and study of material properties.
8. Study of heat treatment processes subjected to critical components of agricultural machinery.

Text Books

1. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributors, Delhi. 99, 1997.
2. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 2010.
3. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005

Reference Books

1. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi, 1996.
2. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

18AT2005 TRACTOR SYSTEMS AND CONTROLS

Credits 2:0:0

Objectives

- To equip the student with sufficient knowledge about tractor and its various systems, their principles of operation and types, components etc.
- To impart knowledge on the concept of traction and mechanics of tractor.
- To introduce the ergonomic and safety considerations in tractors; and tractor testing.

Outcomes

- The students will be able to understand the various components of tractors.
- The students will have the knowledge on earth moving machineries and tractor classification and tillage implements.
- The students will acquire knowledge on the controls and trouble shooting of farm tractors.

Theory

Study of need for transmission system in a tractor. Transmission system – types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio. Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive. Study of Brake system – types, principle of operation, construction, calculation for braking torque. Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC. Study of tractor power outlets – PTO. PTO standards, types and functional requirements. Introduction to traction. Traction terminology. Theoretical calculation of shear force and

rolling resistance on traction device. Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids. Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety.

Text Books

1. Liljedahl, J. B., Turnquist, P. K., Smith, D. W., and Hokey, M. 2004. Tractors and Their Power Units. CBS Publishers and Distributors Pvt. Ltd, New Delhi
2. Jain, S. C., and Rai, C. R. 2013. Farm Tractor Maintenance and Repair. Standard Publishers Distributors, Delhi

Reference Books

1. Kirpal Singh. 2013. Automobile Engineering Vol. I. Standard Publishers Distributors, Delhi
2. Relevant BIS Test Codes for Tractors.
3. Singh, S., and Verma, S. R. 2009. Farm Machinery Maintenance and Management. Indian Council of Agricultural Research, New Delhi
4. Black, P.O. 1996. Diesel engine manual. Taraporevala Sons & Co., Mumbai.
5. Grouse, W.H. and Anglin, D.L. 1993. Automotive mechanics. Macmillan McGraw- Hill, Singapore.
6. Indian Standard Codes for Agril. Implements. Published by ISI, New Delhi.

18AT2006 FARM MACHINERY AND EQUIPMENT-II

Credits 2:0:1

Objectives

- To expose the students to farm mechanization benefits and constraints.
- To equip the students in the identification of components of implements.
- To impart knowledge on the working principles of farm equipments during field operations.

Outcomes

- The students will be able to understand the mechanization in agricultural farms.
- The students will gain knowledge on the various equipment used in the farm for different field operations.
- The students will be able to apply their knowledge on selection of equipments for various operations.

Theory

Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates. Introduction to interculture equipment. Use of weeders – manual and powered. functional requirements of weeders and main components. Familiarization of fertilizer application equipment. Study of harvesting operation – harvesting methods,. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods and calculation of moisture content of hay. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting

mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical

1. Familiarization with plant protection and interculture equipment.
2. Study of sprayers, types, functional components.
3. Study of dusters, types and functional components.
4. Calculations for chemical application rates.
5. Study of nozzle types and spread pattern using patternator.
6. Familiarization with manual and powered weeding equipment and identification of functional components.
7. Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters.
8. Study of various types of mowers, reaper, reaper binder.
9. Familiarization with threshing systems, cleaning systems in threshers.
10. Calculations of losses in threshers.
11. Familiarization with functional units of Grain combines and their types.
12. Calculations for grain losses in a combine.
13. Study of root crop diggers and familiarization with the functional units and attachments.
Familiarization with the working of cotton and maize harvesters.
14. Familiarization with vegetable and fruit harvesters.

Text Books

1. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributors, Delhi. 99, 1997.
2. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 2010.
3. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005

Reference Books

1. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi, 1996.
2. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

18AT2007 FIELD OPERATION AND MAINTENANCE OF TRACTORS AND FARM MACHINERY

Credits 0:0:2

Objectives

- To familiarize the students with agricultural tractors and power tillers, its systems, operation, maintenance and safety precautions.
- To explain the application of different farm machinery in the field on tillage, sowing, plant protection, harvesting and threshing.
- To impart skill and technical know-how on dismantling and reassembling, care, maintenance and safety of farm machines.

Outcomes

- The students will be able to understand the mechanization in agricultural farms.
- The students will gain knowledge on the operation of various equipment used in the farm for different field operations.
- The students will be able to apply their knowledge on selection of equipments for various operations.

Practical

1. Familiarization with different makes and models of agricultural tractors.

2. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems.
3. Study of maintenance points to be checked before starting a tractor.
4. Familiarization with controls on a tractor.
5. Safety rules and precautions to be observed while driving a tractor.
6. Driving practice of tractor.
7. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field.
8. Study of field patterns while operating a tillage implement.
9. Hitching & De-hitching of mounted and trail type implement to the tractor.
10. Driving practice with a trail type trolley – forward and in reverse direction.
11. Introduction to tractor maintenance – precautionary and break-down maintenance.
12. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements.
13. Replacement of furrow openers and change of blades of rotavators.
14. Adjustments in a thresher for different crops. Replacement of V-belts on implements.
15. Setting of agricultural machinery workshop.

Reference Manuals

1. Ghosh, R. K., Swan, S. 1993. Practical Agricultural Engineering. Kolkata NayaPrakosh.
2. Jain, S. C., and Rai, C. R. 2013. Farm Tractor Maintenance and Repair. Standard Publishers Distributors, New Delhi.
3. Operators Manuals of Tractors.
4. Service manuals provided by manufacturers.
5. Surendra Singh, Verma, S. R. 2009. Farm Machinery Maintenance and Management. Indian Council of Agricultural Research, New Delhi.

18AT2008 POST-HARVEST ENGINEERING OF HORTICULTURAL CROPS

Credits 2:0:0

Objectives

- To equip the students with processing and handling of fruits and vegetables.
- To understand the various unit operations involved in the processing of horticultural crops.
- To facilitate the utilization of various equipments used for the processing of fruits and vegetables.

Outcomes

- The students will be able to understand the various processes in post harvest technology of horticultural crops.
- The students will apply their knowledge on the operation of various processing equipments.
- The students will be able to apply their knowledge on selection of equipments for various operations.

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food, Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration, Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms,

mechanical strength), Different types of packaging materials used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, equipment used for different unit operations, Quality control in fruit and vegetable processing industry.

Text Books

1. Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New india Publishing House.
2. Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices), Saroj Prakashan, Allahabad.

Reference Books

1. Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.
2. Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.

18AT2009 SOIL AND WATER CONSERVATION ENGINEERING

Credits 2:0:1

Objectives

- To present the concepts and causes of erosion and the problems associated with it.
- To enable the students to make use of the principles and concepts to solve issues related to soil and water management.
- To equip the students with proper application of different soil and water conservation measures to restore the productivity of the soil.

Outcomes

- The students will be able to gain fundamental knowledge on the concepts of erosion and sedimentation.
- They will have sufficient knowledge on soil and water conservation measures.
- The students will apply their knowledge on the design of various soil and water conservation measures.

Theory

Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.

Practical

1. Study of different types and forms of water erosion.
2. Exercises on computation of rainfall erosivity index.

3. Computation of soil erodibility index in soil loss estimation.
4. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE.
5. Exercises on soil loss estimation/measuring techniques.
6. Study of rainfall simulator for erosion assessment.
7. Estimation of sediment rate using Coshocton wheel sampler and multi-slot depositor. Determination of sediment concentration through oven dry method.
8. Design and layout of contour bunds. Design and layout of graded bunds.
9. Design and layout of broad base terraces.
10. Design and layout of bench terraces.
11. Design of vegetative waterways.
12. Exercises on rate of sedimentation and storage loss in tanks.
13. Computation of soil loss by wind erosion.
14. Design of shelterbelts and wind breaks for wind erosion control.
15. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Text Books

1. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
2. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
3. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Reference Books

1. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
2. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
4. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.

18AT2010 FUNDAMENTALS OF RENEWABLE ENERGY SOURCES

Credits 2:0:0

Objectives

- To make the student aware on the various basic aspects of energy use and its environmental impact.
- To introduce the different classifications of major renewable energy sources and technologies.
- To provide sufficient knowledge on alternate energy sources (solar energy and wind energy) and their applications.

Outcomes

- The students will attain fundamental knowledge on the concepts of bio energy sources and its applications.
- The students will be able to classify the various conventional and renewable energy sources.
- The students will be able to apply their knowledge on the design of solar and wind energy systems.

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data,

solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, working principle of wind power plant. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Text Books

1. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
2. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
3. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

Reference Books

1. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications.
2. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
3. Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.

18AT2011 EXTENSION METHODOLOGIES AND TRANSFER OF AGRICULTURAL TECHNOLOGY

Credits 2:0:0

Objectives

- To enable the learners of to understand the extension and basic communication skills.
- To impart knowledge about the transfer of technology using extension technologies.
- To provide skills on transferring technologies in the field.

Outcomes

- The students will attain the basic concepts of extension and basic communication skills.
- The students will gain knowledge about the transfer of technology using extension technologies.
- The students will be capable of transferring technologies in the field through effective extension methodologies.

Communication and Programme Planning-Communication – meaning – definition – models – elements and their characteristics – types and barriers in communication. Programme planning – meaning, definition, principles, steps in programme development process, monitoring and evaluation of extension programmes. Extension teaching methods - Audio-Visual aids – definition – classification – purpose, planning and selection, combination and use – individual, group and mass contact methods – merits and demerits. Modern communication sources – internet, video and teleconferencing, Interactive Multimedia Compact Disk (IMCD), village kiosks, Kissan Call Centre (KCC), mobile phone. Diffusion and Adoption - Diffusion – meaning and elements. Adoption – meaning –adopter categories and factors influencing adoption, stages of adoption, Innovation decision process and attributes of innovation consequences of adoption. Capacity building of extension personnel and farmers – meaning – definition, types of training, training to farmers, farm women and rural youth, FTC & KVK.

Text Books

1. Ray, G.L., 1999. Extension Communication and Management, Naya Prokash, 206, Bidhan Sarani, Calcutta.
2. Rogers, E.M. 1995. Diffusion of Innovations, The Free Press, Newyork

Reference Books

1. Sandhu, A.S. 1996. Extension Programme Planning, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi
2. Sandhu, A.S. 1996. Agricultural Communication: Process and Methods, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

18AT2012 DAIRY AND FOOD ENGINEERING**Credits 2:0:1****Objectives**

- To disseminate the knowledge of properties of products, unit operations and packaging involved in dairy and food engineering.
- To introduce the students to dairy industry, properties and processing of milk, manufacture of dairy products , sanitation and effluent treatment in dairy industry
- To expose the students to the fundamental knowledge of food, its properties and different methods of food processing

Outcomes

- The students will gain knowledge about Dairy and Food process engineering
- The students will understand the process of manufacturing of dairy products and thermal processing of food.
- The students will understand the importance of quality control and food preservation and packaging.

Theory

Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow charts for product manufacture, Unit operation of various dairy and food processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, paneer, butter and ice cream, Filling and packaging of milk and milk products; Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression, Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Non-thermal and other alternate thermal processing in Food processing.

Practical

1. Study of pasteurizers.
2. Study of sterilizers.
3. Study of homogenizers.
4. Study of separators.
5. Study of butter churns.
6. Study of evaporators.
7. Study of milk dryers.
8. Study of freezers.
9. Study of filtration.
10. Design of food processing plants & preparation of layout.
11. Visit to multi-product dairy plant.

12. Estimation of steam requirements, Estimation of refrigeration requirements in dairy & food plant.
13. Visit to Food industry.

Text Books

1. Tufail Ahmed., “Dairy Plant Engineering and Management”, Kitab Mahal Publishers, Allahabad, 1997.
2. McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
3. Rao, D.G. 2010. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.

Reference Books

1. Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
2. Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.

18AT2013 STORAGE STRUCTURES AND PACKAGING TECHNOLOGY

Credits 2:0:1

Objectives

- To understand the underlying principles of spoilage and storage.
- To highlight the various standards and the environmental parameters involved in the design of such storage structures.
- To provide knowledge on different storage methods and packaging techniques for food materials.

Outcomes

- The students will have a clear understanding of various methods of storage and different packaging techniques for food.
- The students will be able to design proper storage structures for food grains.
- The students will have sufficient knowledge on various packaging materials and their manufacturing process.

Theory

Spoilage and storage- Direct damages, Indirect damages of perishable and durable commodities – control measures - factors affecting storage – types of storage – Losses in storage and estimation of losses. Storage methods- Improved storage methods for grain-modern storage structures-infestation-temperature and moisture changes in storage structures-CAP storage-CA storage of grains and perishables- construction operation and maintenance of CA storage facilities. Functions of packaging materials- Introduction – packaging strategies for various environment – functions of package – packaging materials – cushioning materials – bio degradable packaging materials – shrink and stretch packaging materials. Food Packaging Materials and Testing- Introduction – paper and paper boards - flexible - plastics - glass containers – cans – aluminium foils - package material testing-tensile, bursting and tear strength. Special Packaging Techniques- Vacuum and gas packaging - aseptic packaging - retort pouching – edible film packaging – tetra packaging – antimicrobial packaging – shrink and stretch packaging.

Practical

1. Design of shallow bins
2. Design of deep bins
3. Experiments with evaporative cold storage structure
4. Design of Cold Storage unit
5. Experiment on CA Storage for fruits
6. Experiment on CA Storage for grains
7. Testing of tensile Strength of packaging materials
8. MAP storage of fruits and vegetables
9. Experiment on Vacuum packaging of fruits and vegetables
10. Experiment on canning of fruits
11. Experiment on bottling of fruit products
12. Experiment on Form Fill Seal Machine for Liquids

13. Experiment on Form Fill Seal Machine for Powder foods
14. Visit to FCI godown
15. Visit to packaging Industry

Text Books

1. Sahay, K.M. and K.K.Singh. 1996. Unit Operations of Agricultural Processing. Vikas publishing house Pvt.ltd., New Delhi.
2. Food Packaging Technology, Hand book, 2004. NIIR Board, New Delhi.
3. Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
4. Coles, R., McDowell, D., Kirwan, M .J. 2003. Food Packaging Technology. Blackwell Publishing Co.

Reference Books

1. Himangshu Barman. 2008, Post Harvest Food grain storage. Agrobios (India), Jodhpur.
2. Chakaraverty, A. 2000. third edition. Post harvest technology of cereals, pulses and oil seeds. Oxford & IBH publishing & Co.Pvt.Ltd. New Delhi.
3. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
4. Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.

18AT2014 AGRICULTURAL WASTE AND BY-PRODUCTS UTILIZATION

Credits 2:0:0

Objectives

- To acquaint and equip the students with the proper utilization of agricultural waste and by-products.
- To understand the development of value added products from wastes.
- To identify suitable methods for the conversion of wastes into value added products.

Outcomes

- The students will acquire knowledge on the utilization of agricultural wastes.
- The students will be able to design proper methods for conversion of wastes.
- The students will find solutions for safe and efficient disposal and utilization of various agricultural wastes.

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc., Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters , phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants, Environmental performance of food industry to comply with ISO-14001 standards.

Text Books

1. Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
2. Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
3. Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
4. Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.

Reference Books

1. USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
2. Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
3. V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
4. Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
5. Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
6. Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

18AT2015 GROUND WATER, WELLS AND PUMPS**Credits 2:0:0****Objectives**

- To equip the students with the occurrence, development and hydraulics of ground water flow.
- To understand the theories and application of wells and pumps.
- To impart knowledge in areas of well design, construction and management of wells.

Outcomes

- The students will know the technical aspects of groundwater, its availability, assessment and utilization.
- The students will be familiarized with the theory behind well design.
- The students will have the ability to construct and management of wells.

Theory

Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method(Theis, Jacob and Chow's), Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

Text Books

1. Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill.
2. Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).

Reference Books

1. Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.
2. Raghunath, H.M. Groundwater Hydrology, Wiley Eastern Ltd., 2000.

18AT2016 WATER HARVESTING AND SOIL CONSERVATION STRUCTURES

Credits 2:0:1

Objectives

- To familiarize the water harvesting techniques based on source, storage and use.
- To introduce the soil and water conservation structures.
- To impart awareness on the design requirements, planning for design, design procedures and stability analysis of different structures.

Outcomes

- The students will be able to gain fundamental knowledge on the concepts of water harvesting.
- The students will have sufficient knowledge on soil and water conservation measures.
- The students will be able to design various soil and water conservation structures.

Theory

Water harvesting - principles, importance and issues. Water harvesting techniques- classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - terracing and bunding, rock and ground catchments. Long-term harvesting techniques - purpose and design criteria. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures and stability analysis. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

Practical

1. Study of different types of farm ponds.
2. Computation of storage capacity of embankment type of farm ponds.
3. Design of dugout farm ponds.
4. Design of percolation pond and *nala* bunds.
5. Runoff measurement using H-flume. Exercise on hydraulic jump.
6. Exercise on energy dissipation in water flow.
7. Hydrologic, hydraulic and structural design of drop spillway and stability analysis.
8. Design of SAF stilling basins in chute spillway.
9. Hydrologic, hydraulic and structural design of drop inlet spillway.
10. Design of small earthen embankment structures.
11. Practice on softwares for design of soil and water conservation structures.
12. Field visit to watershed project areas treated with soil and water conservation measures / structures.

Text Books

1. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

2. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II.
3. 4th Edition, Jain Brothers, New Delhi.
4. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Reference Books

1. Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering. 4th Edition, John Wiley and Sons Inc. New York.
2. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
3. Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.

18AT2017 BIO ENERGY SYSTEMS: DESIGN AND APPLICATIONS

Credits 2:0:1

Objectives

- To provide in depth knowledge on basic principles of Bio-energy systems.
- To impart the fundamental knowledge on the importance of Bio resources, Bio energy and reactors.
- To provide skills in design and operation of major bio-energy systems.

Outcomes

- The students will be able to understand the concepts of bio energy sources and its applications.
- The students will be able to find solutions for bio mass conversion into energy.
- The students will be able to apply their technical know-how for the design of bio energy systems.

Theory

Fermentation processes and its general requirements, overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying). Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics. Trans-esterification for biodiesel production. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Practical

1. Study of anaerobic fermentation system for industrial application.
2. Study of gasification for industrial process heat.
3. Study of biodiesel production unit.
4. Study of biomass densification technique (briquetting, pelletization, and cubing).
5. Integral bio energy system for industrial application.
6. Study of bio energy efficiency in industry and commercial buildings.
7. Design of Bio energy systems.
8. Study and demonstration of energy efficiency in building.
9. Measuring efficiency of different insulation technique.
10. Study of Brayton, Striling and Rankine cycles.
11. Study of modern greenhouse technologies.

Text Books

1. British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.
2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.

3. Centre for biomass energy. 1998. Straw for energy production; Technology- Environment-Ecology. Available: www.ens.dk.

Reference Books

1. Chawla, O.P. 1986. Advances in biogas Technology, IARI, New Delhi.
2. Mathur, A.N. and Rathore N.S. 1992. Biogas production, management and utilization. Himanshu Publication. Delhi.
3. Mital, K.M., 1996, Biogas systems; Principles and applications, New Age International (P) Ltd. Publishers, New Delhi.
4. Rai G.D. 1989. Non-conventional Sources of energy. Khanna Publishers. Delhi.

18AT2018 IRRIGATION AND DRAINAGE ENGINEERING

Credits 2:0:1

Objectives

- To develop competency to design water conveyance systems and surface irrigation systems in the field.
- To understand the basic concepts for planning, design and management of land drainage works in cultivated areas.
- To study the various methods of land drainage and its impact on environment

Outcomes

- The students will have technical knowledge and skills on Planning, design, operation and management of reservoir system.
- The students will gain knowledge on different methods of irrigation.
- The students will be able to design proper drainage systems in the field.

Theory

Water Resources- River basins-Development and Utilization in India and Tamil Nadu-Irrigation – duty and delta - Rooting characteristics-Moisture use of crop, Evapotranspiration - ET – plot. Irrigation Requirement- Crop water requirement - Effective rainfall - Scheduling - Irrigation requirement - Irrigation frequency, Irrigation efficiencies. Methods of Irrigation - Hydraulics and design - Erodible and non-erodible, alluvial channels- Kennedy's and Lacey's theories, Materials for lining water courses and field channel, Water control and diversion structure - Underground pipeline irrigation system - Land grading - Land levelling methods. Command Area Development-Command area - Concept, Components of CADA - CADA programmes in Tamil Nadu - On Farm Development works, Execution - maintenance and economics of OFD works, Farmer's committee and its role for water distribution and system operation, Strategic outlet command - stream size for efficient warabandhi and rotational irrigation system. Agricultural drainage and system - Agricultural drainage - Drainage coefficient; principles of flow through soils, Darcy's law – infiltration theory, Surface drainage systems - Subsurface drainage - Design of subsurface drainage - Pipe materials - mole drains, drainage wells, Leaching requirements - irrigation and drainage water quality - recycling of drainage water for irrigation.

Practical

1. River basins, irrigation projects, irrigation tanks and water resources in TN.
2. Determination of soil moisture by different methods (gravimetric, tensiometer, gypsum block and neutron probe method).
3. Problems on duty of water - Duty and delta relationship.
4. Estimation of water requirement by different methods.
5. Estimation of Evapotranspiration.
6. Land levelling - plane method from climatologically data.
7. Determination of irrigation efficiencies.
8. Problems on Border irrigation and Design of Basin irrigation.
9. Design of Furrow irrigation - problems.
10. Problems on Kennedy's and Lacey's theory

11. Design of under ground pipeline system.
12. Problems on Irrigation scheduling.
13. OFD works in command areas.
14. Design of surface drainage system.
15. Design of Sub-surface drainage system.
16. Field visit to command areas and observation of OFD works.

Text Books

1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
2. Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.

Reference Books

1. Luthin. J.N. 1966, Drainage Engineering, John Wiley and Sons, New York.
2. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
3. Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.

18AT2019 MICRO IRRIGATION

Credits 2:0:1

Objectives

- To expose the students to the fundamental knowledge in Pumps for Irrigation use
- To understand the basic concepts for planning, design and management of micro irrigation system.
- To study the implementation of design in field level.

Outcomes

- The students will have technical knowledge and skills on Planning, design, operation and management of micro irrigation system.
- The students will gain knowledge on different methods of micro irrigation.
- The students will be able to design proper micro irrigation systems in the field.

Theory

WATER LIFTS AND PUMPS-Pump classification Variable displacement pumps–Centrifugal pump-Submersible pump- Vertical,Turbine pumps mixed flow – Jet and Airlift pumps-Pump selection and installation- Pump troubles and Remedies. PUMP VALVES-Types of valves- Pressure relief valve- Gate valve-Isolated valve- Non return valve- Butterfly valve- Solenoid valves- Automated control valve-selection, repair and maintenance. MICRO IRRIGATION CONCEPT AND APPLICATIONS-Micro irrigation- Comparison between Traditional and Micro irrigation methods -Merits and demerits of micro-irrigation system, Types and components of micro irrigation system- Scope and potential problem of micro irrigation - Low cost Micro irrigation Technologies- Gravity fed micro irrigation -Care and maintenance of micro-irrigation System- Economics of micro-irrigation system - Automation in micro-irrigation-Surge and cabling irrigation- Greenhouse irrigation system. DRIP IRRIGATION DESIGN -Drip irrigation - Components- Dripper- types and equations governing flow through drippers- Wetting pattern- Chemigation application- Pump capacity-Installation- Operation and maintenance of Drip irrigation system. - Design of surface and sub-surface drip irrigation. SPRINKLER IRRIGATION DESIGN -Sprinkler irrigation- Components and accessories - Hydraulic design - Sprinkler selection and spacing- Capacity of sprinkler system - types - Sprinkler performance- Sprinkler discharge- Water distribution pattern- Droplet size, filtering unit, fertigation - System maintenance

Practical

1. Study of different components of sprinkler irrigation system, Design and installation of sprinkler irrigation system
2. Determination of precipitation pattern, discharge and uniformity coefficient ,Cost economics of sprinkler irrigation system
3. Study of different components of drip irrigation, Design and installation of drip irrigation system

4. Study of different types of filters, Determination of filtration efficiency
5. Determination of rate of injection and calibration for chemigation/fertigation
6. Design of irrigation and fertigation schedule for crops
7. Evaluation of drip system, Determination of pressure discharge relationship and emission uniformity for given emitter, Cost economics of drip irrigation system.
8. Field visit to micro- irrigation system

Text Books

1. Suresh, R., "Principles of Micro-Irrigation Engineering", Standard Publishers Distributors, New Delhi, 2010.
2. Michael, A.M., "Irrigation Theory and Practice", Vikas Publishers, New Delhi, 2002.

Reference Books

1. Modi, P.N., and Seth, S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 1991.
2. Jack Keller and Rond Belisher., "Sprinkler and Trickle Irrigation", Vannistrand Reinhold, New York, 1990.
3. Sivanappan R.K., "Sprinkler Irrigation", Oxford and IBH Publishing Co., New Delhi, 1987.
4. Keller.J and D. Karmeli, "Trickle Irrigation Design", Rainbird Sprinkler Irrigation Manufacturing Corporation, Glendora, California, USA.

18AT2020 PROCESS ENGINEERING FOR SPICES AND PLANTATION CROPS

Credits 2:0:0

Objectives

- To equip the students with processing spices and plantation crops.
- To understand the various processing steps involved for different plantation products, spices and aromatic and medicinal plants.
- To facilitate the utilization of various equipments used for processing.

Outcomes

- The students will be able to understand the various processes involved in the processing of spices and plantation crops.
- The students will apply their knowledge on the operation of various processing equipments.
- The students will be able to select proper equipments for various operations.

Importance and processing of spices – production and importance – stage of harvesting and harvesting methods - processing of major and minor spices – pepper, cardamom, chilli, turmeric, ginger, clove, nutmeg, vanilla – unit operations involved – equipments – principle and construction. Packaging, grading and quality analysis of spices- Cleaning and grading of spices - packaging and storage of spices – grading specifications – Agmark, ASTA, ESA specifications - processes involved in the manufacture of oleoresins and essential oils – quality analysis of spices and their derivatives. Processing of coffee, tea, cocoa and rubber – methods, process and equipment – value added products – grading and types - packaging and storage Processing of plantation crops- Processing of coconut, oilpalm, arecanut and cashew- production and importance – processing of coconut, oilpalm, arecanut, cashew– harvesting and stages of harvest – drying, cleaning and grading – production of value added products – packaging and storage of produces. Processing of medicinal crops- Importance of medicinal crops – production and export status - processing of medicinal crops - equipments used - principles and operations – active principles in various medicinal plants – application and uses - extraction methods

Text books

1. Pandey, P. H. 2002. Post Harvest Engineering of Horticultural Crops through Objectives. Saroj Prakasam, Allahabad.

2. Pruthi, J.S. 1998. Major Spices of India – Crop Management and Post Harvest Technology. Indian Council of Agricultural Research, Krishi Anusandhan Bhavan, Pusa, New Delhi. PP. 514.

Reference books

1. ASTA, 1997. Official analytical methods of the American Spice Trade Association, Fourth Edition.
2. Purselove, J.W., E.G.Brown, G.L.Green and S.R.J.Robbins. 1981. Cardamom – Chemistry. Spices, Vol. I, Tropical Agricultural Series, Longman, London, 1: 605.
3. Pruthi, J.S. 1980. Spices and Condiments: Chemistry, Microbiology and Technology. First Edition. Academic Press Inc., New York, USA. pp. 1-450.

18AT2021 APPLICATION OF RS AND GIS IN AGRICULTURE

Credits 2:0:0

Objectives

- To provide exposure to students in gaining knowledge on concepts and applications using Remote Sensing, GIS and GPS technologies.
- To acquire skills in storing, managing digital data for planning and development.
- To study the applications of Remote Sensing and GIS in agriculture, soil and water resources.

Outcomes

- The students will understand the remote sensing principles, remote sensing systems satellite data processing and available data products.
- The students will understand decision making process using DBMS and utilization of these advanced techniques in addressing the real world problems.
- The students will apply their skills on RS and GIS in agriculture, soil and water resources.

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation-interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Text Books

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.

Reference Books

1. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education Limited, UK.
2. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
3. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
4. Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
5. Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

18AT2022 PROCESS EQUIPMENT DESIGN

Credits 2:0:0

Objectives

- To equip the students to study the design aspects of the food processing equipments.
- To understand the relationship between process design and safety.
- To acquire knowledge on computer aided design of equipments

Outcomes

- The students will understand the various design aspects of the food processing equipments.
- The students will be able to design the process equipments.
- The students will be able to evaluate performance of process equipments.

Introduction on process equipment design, Application of design engineering for processing equipments, Design parameters and general design procedure, Material specification, Types of material for process equipments, Design codes, Pressure vessel design, Design of cleaners. Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger, Design of belt conveyer, screw conveyer and bucket elevator, Design of dryers. Design of milling equipments. Optimization of design with respect to process efficiency, energy and cost, Computer Aided Design.

Text Books

1. Mahajani, V. V. and Umarji, S. B., Process equipment design, Macmillan.
2. Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors.
3. Geankoplis, C.J. 1997, Transport processes and Unit operations, Prentice Hall of India Publication, New Delhi
4. Rao, D. G. 2010, Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

Reference Books

1. Brounsel and Young, 1993, Process Equipment Design.
2. James, M. More, 1976, Plant Layout and Design. MacMillan Publishing Co., New York.
3. Perry, R.H and C.H. Chilton, 1973, Chemical Engineering Hand Book. McGraw Hill, Tokyo.

18AT2023 DEVELOPMENT OF PROCESSED PRODUCTS

Credits 2:0:0

Objectives

- To equip the students to study the various processes involved in the development of products.
- To understand the correct unit operation for each product.
- To acquire knowledge on selection of suitable equipments for product development.

Outcomes

- The students will understand various processes involved in the development of products.
- The students will be able to identify suitable unit operation for processed product.
- The students will be able to evaluate selection of suitable equipments for product development.

Theory

Process design, Process flow chart with mass and energy balance, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds, Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from fruits, vegetables and spices, Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, spice extracts, Technology for animal produce processing , meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food.

Text Books

1. Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
2. Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.
3. Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.
4. Acharya, K T Everyday Indian Processed foods. National Book Trust.

Reference Books

1. Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers.
2. Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal technology. Kalyani Pub.

18AT2024 FARM MACHINERY DESIGN AND PRODUCTION**Credits 2:0:0****Objectives**

- To equip the students about the importance of various farm machinery.
- To understand the design aspects of farm machinery and implements.
- To gain expertise on the design and production of farm machinery.

Outcomes

- The students will understand the importance of various farm machinery.
- .The students will be able to understand the design aspects of farm machinery and implements.
- The students will be able to design and evaluate farm machinery and implements.

Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits & Tolerances, Jigs & Fixtures. Industrial lay-out planning, Quality production management. Reliability. Economics of process selection. Familiarization with Project Report.

Text Books

1. Richey, C.B. Agricultural Engineering Handbook.
2. Adinath M and AB Gupta. Manufacturing Technology.
3. Sharma PC and DK Aggarwal. Machine Design.

Reference Books

1. Narula V. Manufacturing process.
2. Singh S. Mechanical Engineer's Handbook.
3. Chakrabarti NR. Data book for Machine Design.

18AT2025 TRACTOR DESIGN AND TESTING**Credits 2:0:0****Objectives**

- To acquaint the students about the various aspects of design of tractors.
- To equip with the testing procedures.
- To gain expertise on the design and testing of farm tractors.

Outcomes

- The students will gain knowledge on the various aspects of design of tractors.
- The students will be equipped with the testing procedures for tractors.
- The students will be able to design and test farm tractors.

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, traction theory, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman Steering and tractor hydraulic steering. Study of special design features of tractor engines and their selection viz. cylinder, piston, piston pin, crankshaft, etc. Design of seat and controls of an agricultural tractor. Tractor Testing.

Text Books

1. Liljedahl J B & Others. Tractors and Their Power Units.
2. Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.
3. Maleev VL. Internal Combustion Engines.

Reference Books

1. Kirpal Singh. Automobile Engineering – Vol I and Vol II.
2. Richey C.B. Agricultural Engineering Handbook.
3. Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.

18AT2026 MECHANICS OF TILLAGE AND TRACTION**Credits 2:0:0****Objectives**

- To understand the basic concepts on the mechanics of tillage and traction.
- To develop knowledge on power requirement for tillage.
- To study the various parameters in tillage operation.

Outcomes

- The students will understand the basic concepts the mechanics of tillage and traction.
- The students will gain on power requirement for tillage.
- The students will understand various parameters in tillage operation.

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and application of GIS in soil dynamics.

Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Text Books

1. Vandenberg and Gill. Tillage and Traction.
2. Liljedahl JB and others. Tractor and Power Units.
3. Daniel Hill. Fundamentals of Soil Physics.
4. Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.

18AT2027 ERGONOMICS, HUMAN ENGINEERING AND SAFETY IN AGRICULTURAL MACHINERY

Credits 2:0:0

Objectives

- To impart basic knowledge in Ergonomics by understanding the fundamental Concepts
- To acquaint and equip with the ergonomic aspects in the design of farm machinery for more output and safety of human beings.
- To understand the basic concepts on human engineering and safety.

Outcomes

- The students will understand the fundamental concepts ergonomics and human engineering.
- The students will gain on safety aspects of machinery.
- The students will apply their knowledge in manufacturing industry.

Theory

Importance of ergonomics and its application in agriculture; Energy liberation in human body; Assessment of energy expenditure- direct calorimetry, Indirect calorimetry- Assessment by oxygen consumption; Techniques of measuring oxygen consumption; Assessment by heart rate and calibration; Assessment by subjective rating of perceived effort- Overall discomfort score and BPDS; Basal metabolism and work metabolism; Assessment of work load; Assessment of Individual's maximal work capacity. Anthropometry; Anthropometric data and measurement techniques; Anthropometric dimensions and strength parameters; Causes of variability of anthropometric data; Analysis of anthropometric data and use of percentiles. Biomechanics of motion. Vibration- hand arm vibration and whole body vibration, physiological effects; Noise and its physiological effects. Human factors in system development – concept of systems; basic processes in system development; performance reliability, human performance; Metabolic system, human energy machine, Human metabolism and work; Energy liberation in human body; Energy for muscle work; Assessment of energy expenditure- direct calorimetry, Indirect calorimetry; Techniques of measuring oxygen consumption; Assessment of work load; Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications.

Text Books

1. Astrand, P.O and Rodahl, K.1977. Text book of work physiology, McGraw Hill, New York
2. Bridger, R.S,1995. Introduction to Ergonomics, McGraw Hill, New York
3. Dul J and Weerdmeester B.1993.Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
3. Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.

Reference Books

1. Mathews J. and Knight A. A. 1971.Ergonomics in Agricultural Equipment Design.National Institute of Agricultural Engineering.

18AT2028 DRIP AND SPRINKLER IRRIGATION-DESIGN AND INSTALLATION

Credits 0:0:10

Objectives

- To understand the basic concepts on drip and sprinkler irrigation systems.
- To know the various components of drip and sprinkler irrigation systems.
- To acquire knowledge on the design and installation of drip and sprinkler irrigation systems.

Outcomes

- The students will understand the basic concepts on drip and sprinkler irrigation systems.
- The students will gain knowledge on the various components of drip and sprinkler irrigation systems.
- The students will be able to design and installation of drip and sprinkler irrigation systems.

Practical

Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system; study of different components of drip irrigation; design and installation of drip irrigation system; determination of pressure discharge relationship and emission uniformity for given emitter; study of different types of filters and determination of filtration efficiency; determination of rate of injection and calibration for chemigation/fertigation; design of irrigation and fertigation schedule for crops; field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.

Text Books

1. Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .
2. Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.
3. Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.

Reference Books

1. Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.
2. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.
3. Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.

18AT2029 WATERSHED MANAGEMENT-CONCEPT AND STRATEGIES

Credits 0:0:10

Objectives

- To understand a comprehensive idea about watershed management.
- To know the various strategies for watershed management.
- To acquire knowledge on planning and execution of watershed management projects.

Outcomes

- The students will understand the basic concepts and ideas about watershed management.
- The students will gain knowledge on the various strategies for watershed management.
- The students will be capable of planning and execution of watershed management projects.

Practical

Exercises on delineation of watersheds using toposheets. Surveying and preparation of watershed map. Quantitative analysis of watershed characteristics and parameters.

Watershed investigations for planning and development. Analysis of hydrologic data for planning watershed management.

Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index.

Study of functional requirement of watershed development structures.

Study of watershed management technologies.

Practice on softwares for analysis of hydrologic parameters of watershed. Study of role of various functionaries in watershed development programmes.

Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.

Text Books

1. Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
3. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.

Reference Books

1. Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
2. Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
3. Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.
4. Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.
5. Tideman, E.M. 1999. Watershed Management: Guidelines for India Conditions, Omega Scientific Publishers, New Delhi.

18AT2030 PRECISION FARMING IN THE SEMI-ARID AND HUMID TROPICAL ZONES

Credits 0:0:10

Objectives

- To understand the technology of precision farming.
- To know the various system concepts in precision farming.
- To acquire knowledge on planning and execution precision farming techniques using modern techniques.

Outcomes

- The students will understand the basic concepts and technology of precision farming.
- The students will gain knowledge on the various system concepts in precision farming.
- The students will be capable of planning and execution of precision farming techniques.

Practical

Precision Agriculture – need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, straw-chopper, straw-balers, grain combines, etc.

Introduction to GIS based precision agriculture and its applications. Introduction to sensors and application of sensors for data generation.

Database management. System concept. System approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations.

Application to PERT and CPM for machinery system management

Solving problems related to various capacities, pattern efficiency, system limitation, etc.

Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

Text Books

1. Brahma Singh, Balraj Singh, NavedSabir and MurtazaHasan, 2014.Advances in Protected Cultivation.New India Publishing Agency, New Delhi.
2. Donell Hunt, 2013.Farm Power and Machinery Management.10th edition.MedTec Publishers, New Delhi.
3. Jana, B. L., 2008. Precision Farming.AgroTech Publishing Academy.

Reference Books

1. Kali CharanSahu, 2008. Text Book of Remote Sensing and Geographical Information Systems.Atlantic Publishers and Distributors Pvt Ltd.
2. K. RadhaManohar and C. Ignathinathane. 2015.Greenhouse Technology and Management. 2nd edition. B. S. Publications.

18AT2031 MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT

Credits 0:0:10

Objectives

- To familiarize students about the basic concepts of Irrigation Management and command area development.
- To impart knowledge about the functioning of Irrigation projects and their performance aspects.
- To prepare the students on the activities of command area development and on farm irrigation activities.

Outcomes

- The students will understand the basic concepts of Irrigation Management and command area development.
- The students will gain knowledge about the functioning of Irrigation projects and their performance aspects.
- The students will be capable of planning and execution of command area development and on farm irrigation activities.

Practical

Factors affecting performance of irrigation projects; types of minor irrigation systems in India.

Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems.

Tank Irrigation: grouping of tanks, storage capacity, supply works and sluices.

Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities-functions and responsibilities; on farm development works, reclamation works, use of remote sensing techniques for CAD works; water productivity: concepts and measures for enhancing water productivity; Farmers' participation in command area development;

Preparation of command area development layout plan; Irrigation water requirement of crops; Preparation of irrigation schedules; Planning and layout of water conveyance system; design of surplus weir of tanks; determination of storage capacity of tanks; design of intake pipe and pump house.

Text Books

1. Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
2. Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

Reference Books

1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.

2. Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

18AT2032 LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT

Credits 0:0:10

Objectives

- To acquaint students about the basic concepts of landscape design.
- To impart knowledge about the design aspects of landscape.
- To provide hands on experience on the design and implementation of landscape irrigation and management.

Outcomes

- The students will attain the basic concepts of landscape design.
- The students will gain knowledge about the design aspects of landscape.
- The students will be capable of designing and execution landscape irrigation and management.

Practical

Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes.

Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems.

Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria.

Types of pipes, pressure ratings, sizing and selection criteria.

Automation system for landscape irrigation- main components, types of controllers and their application.

Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems. Determination of power requirement, pump selection. Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments.

Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc.

Visit to landscape irrigation system and its evaluation.

Text Books

1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.
2. Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore.
3. Smith Stephen W. Landscape Irrigation and Management. Amazon. com.

18AT2033 AGRO PROCESSING INDUSTRY- DESIGN AND MANAGEMENT

Credits 0:0:10

Objectives

- To acquaint students about the basic design concepts of agro industry.
- To impart knowledge about the design aspects of processing industry.
- To provide technical know-how on the preparation of project reports.

Outcomes

- The students will attain the basic concepts of agro industry.
- The students will gain knowledge about the design aspects of processing industry.
- The students will be capable of preparing project reports for setting various processing units.

Practical

1. Preparation of project report.

2. Preparation of feasibility report.
3. Salient features and layout of pre processing house.
4. Salient features and layout of Milk and Milk product plants- Evaluation of given layout.
5. Salient features, design and layout of modern rice mill.
6. Salient features, design and layout of Bakery and related product plant.
7. Study of different types of records relating to production of a food plant.
8. Study of different types of records relating to finance of a food plant.
9. Study of different types of records relating to marketing of a food business.
10. Brain storming and SWOT analysis to start a food processing business.

Text Books

1. Hall, H.S. and Rosen, Y.S. Milk Plant Layout. FAO Publication, Rome.
2. López Antonio. Gómez. Food Plant Design.
3. Robberts Theunis C. Food plant engineering systems by, CRCpress, Washington.
4. Maroulis Z B and Saravacos G D. Food plant economics. Taylor and Francis, LLC

Reference Books

1. Mahajan M. Operations Research. Dhanpat Rai and Company Private Limited, Delhi
2. Maroulis Z B. Food Process Design. Marcel Dekker, Inc ,Cimarron Road, Monticello, New York 12701, USA.

18AT2034 FARM MACHINERY AND POWER

Credits 1:0:1

Objectives

- To enable the students to understand the various farm implements and equipments.
- To impart knowledge about the application of implements for various operations.
- To provide technical know-how on working of equipments.

Outcomes

- The students will understand the various farm machinery.
- The students will gain knowledge about the use of farm machines.
- The students will understand the working of on working of equipments.

Theory

Status of Farm Power in India, Sources of Farm Power , I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication ,fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor , Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage implement, Implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practical

1. Study of different components of I.C. engine.
2. Learning of tractor driving,
3. Familiarization with operation of power tiller.
4. Familiarization with different types of primary and secondary tillage implements
5. Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter
6. Familiarization with different types of sprayers and dusters
7. Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

Text Books

1. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributors, Delhi. 99, 1997.
2. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 2010.
3. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005

Reference Books

1. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi, 1996.
2. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

18AT2035 SOIL AND WATER CONSERVATION**Credits 1:0:1****Objectives**

- To enable the students to understand the concept of soil and water conservation.
- To impart knowledge about the various causes for soil erosion.
- To provide technical know-how on soil and water conservation measures.

Outcomes

- The students will attain the basic concepts of soil and water conservation.
- The students will gain knowledge about the various causes for soil erosion and prevention methods.
- The students will understand the various soil and water conservation measures.

Theory

Introduction to Soil and Water Conservation, causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal Loss Soil Equation. Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways and their design. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

1. Calculation of erosion index. Estimation of soil loss.
2. Measurement of soil loss.
3. Preparation of contour maps.
4. Design of grassed water ways.
5. Design of contour bunds.
6. Design of graded bunds.
7. Design of bench terracing system.
8. Problem on wind erosion.

Text Books

1. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
2. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
3. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Reference Books

1. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

2. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

18AT2036 SKILL DEVELOPMENT TRAINING-I (STUDENT READY)

Credits 0:0:5

Objective:

To train the students on skill development.

Summer break after IV semester -Student READY Skill Development Training -I for five weeks in the summer break after IV semester with a credit load of 0+5 credit hours.

18AT2037 10-WEEKS INDUSTRIAL ATTACHMENT/INTERNSHIP(STUDENT READY)

Credits 0:0:10

Objective:

To impart training in industries.

Semester VII - Industrial attachment of 10 weeks with local industries.

18AT2038 10-WEEKS EXPERIENTIAL LEARNING ON CAMPUS (STUDENT READY)

Credits 0:0:10

Objective:

To conduct trials in the field for onsite learning..

Semester VII - On campus Experiential Learning Program of 10 weeks with a credit load of 0+10 credit hours by selecting subjects given in the syllabus.

18AT2039 SKILL DEVELOPMENT TRAINING-II (STUDENT READY)

Credits 0:0:5

Objective:

To train the students on skill development.

Summer break after VI semester- Student READY Skill Development Training -II for five weeks in the summer break after VI semester

18AT2040 EDUCATIONAL TOUR

Credits 0:0:2

Objective:

To expose the various research organizations to gain on the field knowledge.

Visit to places of interest in Tamil Nadu & Pondicherry States related to the subjects taught in Farm Machinery and Power, soil and Water Conservation Engineering, Food and Agricultural Process Engineering, Bio Energy and Agricultural Structures, Viz.,

18AT2041 PROJECT PLANNING AND REPORT WRITING

Credits 0:0:10

Objective:

To prepare the student for project and field study of selected topic.

Identification of problem – literature collection – fabrication of equipments – land preparation – preliminary testing of equipments / layout of irrigation trails – parametric data collection.

18AT2042 RENEWABLE ENERGY AND GREEN TECHNOLOGY

Credits 1:0:1

Objectives

- To enable the students to understand the concept of renewable energy.
- To impart knowledge about the various green technology techniques.
- To provide technical know-how on renewable energy measures.

Outcomes

- The students will gain the basic knowledge of renewable energy.
- The students will design renewable energy structures.
- The students will analyze the green energy techniques.

Theory

Classification of energy sources, contribution of these of sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application, Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and biooil production and their utilization as bioenergy resource, introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application, introduction of wind energy and their application.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, To study gasifier, To study the production process of biodiesel, To study briquetting machine, To study the production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing. To study solar cooker, To study solar drying system. To study solar distillation and solar pond.

Text Books

1. Rai G.D. 2013. Non-conventional Sources of energy. Khanna Publishers. Delhi.
2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.
3. Chawla, O.P. 1986. Advances in biogas Technology, IARI, New Delhi.
4. Sukhatme, S.P. and Nayak, J.K. 2012. Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi

Reference Books

1. Mathur, A.N. and Rathore N.S. 1992. Biogas production, management and utilization. Himanshu Publication. Delhi.
2. Mital, K.M., 1996, Biogas systems; Principles and applications, New Age International (P) Ltd. Publishers, New Delhi.
3. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

18AT2043 PROTECTED CULTIVATION AND SECONDARY AGRICULTURE

Credits 1:0:1

Objectives

- To enable the students to know the basics of protected cultivation.
- To impart knowledge about the various techniques involved in protected cultivation.
- To provide technical know-how on secondary agriculture.

Outcomes

- The students will understand the basic concepts of protected cultivation.
- The students will design improved protected cultivation measures.
- The students will analyze cost economics in secondary agriculture.

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Green house environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, typical applications, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis. Important Engineering properties such as physical, thermal and aero & hydrodynamic properties of cereals, pulses and oilseed, their application in PHT equipment design and operation. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of green house equipments. Visit to various Post Harvest Laboratories. Determination of Moisture content of various grains by oven drying & infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

Text Books

1. Brahma Singh, Balraj Singh, NavedSabir and MurtazaHasan, 2014.Advances in Protected Cultivation.New India Publishing Agency, New Delhi.
2. Donell Hunt, 2013.Farm Power and Machinery Management.10th edition.MedTec Publishers, New Delhi.
3. Jana, B. L., 2008. Precision Farming.AgroTech Publishing Academy.

Reference Books

1. Kali CharanSahu, 2008. Text Book of Remote Sensing and Geographical Information Systems.Atlantic Publishers and Distributors Pvt Ltd.
2. K. RadhaManohar and C. Ignathinathane. 2015.Greenhouse Technology and Management. 2nd edition. B. S. Publications.

18AT2044 WATER QUALITY AND MANAGEMENT MEASURES

Credits 2:0:0

Objectives

- To enable the students to know the basics of water and its quality.
- To impart knowledge about the various techniques involved in water quality testing.
- To provide technical know-how on managing water quality.

Outcomes

- The students will understand the basics of water quality.
- The students will find measures to solve water quality..
- The students will design methods to find solutions for water testing.

Theory

Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria, point and non-point water pollution sources, water contamination due to inorganic and organic compounds, water

contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures, water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

Text Books

1. Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
2. Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
3. Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.

Reference Books

1. FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55.
2. McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.
3. Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.
4. Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.

18AT2045 BASICS OF MATLAB PROGRAMMING

Credits 2:0:0

Course objectives:

- To understand the fundamentals of MATLAB.
- To impart basic knowledge on simulation and modeling.
- To know the importance of dynamics and control.

Course outcomes:

- The students will understand the role of MATLAB programming.
- The students will study various methods of plotting.
- The students will compute solutions for various properties for various water and environmental problems.

Theory

Basic Matlab programming: algorithm, pseudo-code, flow chart, interface, data types- expressions, constants, variables, assignment statement, arrays-control statements: if, else, then, while, for loop, nested loop, switch/case- functions and scripts- formatted input and output statements-reading from and writing to a text file-sorting-basic plotting: 2D and 3D plots, figures and sub plots - graphics handling, objects-application examples in environmental and water resources engineering.

Text Books

1. Holy, M, MATLAB for Engineers, Prentice Hall, 3rd Edition, 2012.
2. Rudra, P, Getting started with MATLAB: AQuick Introduction for Scientists and Engineers, Oxford University Press, 2010.

Reference Books

1. Duane, C.H, Mastering MATLAB, Pearson Education Inc., 2012.
2. Amos, G, MATLAB: An Introduction with Applications, 4th Edition, 2011

18AT2046 FARM MECHANIZATION – FIELD STUDY

Credits 0:0:10

Objectives

- To impart basic knowledge in farm mechanization.
- To acquaint and equip with the farm machinery for different crops.

- To understand the economics of using agricultural machinery.

Outcomes

- The students will understand the various farm machinery used in farms.
- The students will gain knowledge on usage aspects of farm mechanization.
- The students will apply their knowledge in mechanization of the farm.

Practical

Familiarization with different farm implements and tools.

Problems on machinery management.

Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements.

Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments.

Study of transplanters – paddy, vegetable, etc.

Familiarization with plant protection and intercultural equipment.

Study of sprayers, types, functional components.

Study of dusters, types and functional components.

Study of various types of mowers, reaper, reaper binder.

Familiarization with threshing systems, cleaning systems in threshers.

Calculations of losses in threshers.

Familiarization with functional units of Grain combines and their types.

Text Books

1. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributors, Delhi. 99, 1997.
2. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 2010.
3. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005

Reference Books

1. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi, 1996.
2. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

18AT2047 TESTING OF FARM MACHINERY AND EQUIPMENTS

Credits 0:0:10

Objectives

- To impart basic knowledge in testing of farm machinery.
- To acquaint and equip the economics of farm equipments.
- To understand the methods of testing various farm machinery.

Outcomes

- The students will understand the various methods of testing.
- The students will gain knowledge on application of testing farm equipments.
- The students will apply their knowledge in farm machinery testing.

Practical

Problems on machinery management, Study of primary and secondary tillage machinery –calculations of power and draft requirements. Study of sowing and planting equipment –calculation for calibration and adjustments. Study of transplanters – paddy, vegetable. Familiarization with plant protection and intercultural equipment. Study of sprayers, types, functional components. Study of dusters, types and functional components. Familiarization with threshing systems, cleaning systems in threshers-Calculations of losses in threshers. Testing of Grain combines and harvesters.

Text Books

1. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributors, Delhi. 99, 1997.

2. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 2010.
3. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005

Reference Books

1. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi, 1996.
2. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

18AT2048 VALUE ADDITION OF INDIGENOUS FRUITS AND VEGETABLES

Credits 0:0:10

Objectives

- To acquaint students about the basics of value addition of fruits and vegetables.
- To impart knowledge about methods of preserving fruits and vegetables.
- To provide technical know-how on the preparation of project reports for preservation techniques.

Outcomes

- The students will attain the basic concepts of value addition.
- The students will gain knowledge about the methods of processing indigenous fruits and vegetables.
- The students will be capable of preparing project reports for setting processing units for indigenous fruits and vegetables.

Practical

Selection of indigenous fruits and vegetables. .
Study of their quality attributes.
Study of physical and chemical parameters.
Preparation of processing techniques.
Preparation of project reports for value addition.

Text Books

1. Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.
2. Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad.

Reference Books

1. Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New india Publishing House.
2. Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.

18AT2049 APPLICATIONS OF SOLAR AND WIND ENERGY IN AGRICULTURE

Credits: 3:0:0

Course Objectives

- To learn about the principles and applications of solar and wind energy in agriculture
- To familiarize with the concept of photovoltaic technology.
- To understand the wind mapping analysis.
- To know about various alternate energy sources.

Course Outcome

At the end of this course, the students will be able to

- Understand the applications of Solar energy in agriculture
- Know about the applications of wind energy in agriculture.
- Familiar with the idea of photovoltaic technology.

- Analyse wind mapping
- Gain sufficient knowledge on different alternate energy sources.

Theory

Introduction of Renewable energy - World energy scenario –Energy sources and their availability; Qualitative study of different renewable energy resources – Solar – wind – ocean – Biomass - Fuel cell - Hydrogen energy systems and hybrid renewable energy systems. Solar radiation availability – Radiation measurement – collectors – Types - Flat-plate collector - Liquid collector- Air collectors (Solar air heaters) - concentrating collectors - Types – parabolic trough collector – Mirror strip reflector- Fresnel lens collector; Application of solar energy - solar thermal power station - solar furnace - solar greenhouses - Solar stills - solar pond – solar pump – solar drier.

Photovoltaic Energy Conversion - solar cells and their characteristics - PV arrays -Electrical storage with batteries - inverter -selection of inverter - battery sizing - array sizing; PV Applications - Standalone inverters -Charge controllers - street lighting; Hybrid system - solar technology in green buildings.

Nature of wind - wind structure and measurement - wind power laws - velocity and power duration curves - aerofoil – tip-speed ratio - torque and power characteristics - power coefficients - Betz coefficient. Turbines - Windmill - classification - power curve; Upwind and downwind systems - transmission rotors - pumps - generators - standalone system - grid system – batteries; Wind energy storage - wind farms - wheeling and banking - testing and certification procedures.

Text Books

1. Rai., G.D. “Solar Energy Utilization” Khanna publishers, New Delhi, 2002
2. More, H.S & R.C.Maheswari, “Wind Energy Utilization in India” CIAE Publication – Bhopal, 1982.
3. Rao. S and B.B. Parulekar. Energy Technology - Non conventional, Renewable and Conventional. Khanna Publishers, Delhi, 2000.

References

1. Mathew Buresch, Photovoltaics Energy Systems. McGraw-Hill Book Company, London, 1986.
2. JuiSheng Hsieh. Solar Energy Engineering, Prentice Hall, London, 1986.
3. TanyBurtar, Hand book of wind energy. John Wiley and Sons, 2001.
1. J.G.Mc Gowan, Manwell, J.F. and A.L.Rogers. Wind Energy Explained - Theory Design and Application, John Wiley and Sons Ltd, 2004.
2. John Twidell. A guide to small wind energy conversion system, Cambridge University press. UK, 1987
3. Rai. G.D. “Non-Conventional Sources of Energy”, Khanna Publishers, New Delhi, 2002

18AT2050 SKILL DEVELOPMENT TRAINING-I (STUDENT READY)

Credits 0:0:5

Course Objectives

- To train the students on skill development.
- To create opportunities and scope for the development of the talents of the students
- To improve on self-entrepreneurship

Course Outcome

- The students will be empowered with technical skills
- The students will be channelized for proper job opportunities
- The students will get exposure in career development
- The students will be able to demonstrate various applications of farm implements to the farmers
- The students will be able to understand the practical problems and remedial measures
- The students will be able to identify the method of improvement of the process in the field.

Summer break after IV semester -Student READY Skill Development Training -I for five weeks in the summer break after IV semester with a credit load of 0+5 credit hours.

18AT2051 10-WEEKS INDUSTRIAL ATTACHMENT/INTERNSHIP (STUDENT READY)

Credits 0:0:10

Course Objectives

- To impart training in industries.
- To create opportunities and scope for the development of the talents of the students
- To improve on self-entrepreneurship

Course Outcome

- The students will be able to acquire technical skills
- The students will be channelized in entrepreneurship
- The students will get exposure for career development
- The students will be able to fabricate the implements of desired specification
- The students will be able to gain knowledge about the manufacturing technology of the products
- The students will be able to calculate the quantity requirement for different farm operations

Semester VII - Industrial attachment of 10 weeks with local industries.

18AT2052 10-WEEKS EXPERIENTIAL LEARNING ON CAMPUS (STUDENT READY)

Credits 0:0:10

Course Objectives

- To conduct trials in the field for onsite learning.
- To create conceptual knowledge and adaptive skills
- To gain practical experience and proper planning for execution of work

Course Outcome

The students will be able to

- focus on results of the learning experiences
- reflect the desired end of the learning experience, not the means or the process
- represent the minimum performances that must be achieved to successfully complete a program;
- get confidence and answer the question of the concerned field
- prepare farm products of desired specification
- evaluate the quality of the prepared products

Semester VII - On campus Experiential Learning Program of 10 weeks with a credit load of 0+10 credit hours by selecting subjects given in the syllabus.

18AT2053 SKILL DEVELOPMENT TRAINING-II (STUDENT READY)

Credits 0:0:5

Course Objectives

- To train the students on skill development.
- To create opportunities and scope for the development of the talents of the students
- To improve on self-entrepreneurship

Course Outcome

- The students will be empowered with technical skills
- The students will be channelized for proper job opportunities
- The students will get exposure in career development
- The students will be able to demonstrate various applications of farm implements to the farmers
- The students will be able to understand the practical problems and remedial measures
- The students will be able to identify the method of improvement of the process in the field.

Summer break after VI semester- Student READY Skill Development Training -II for five weeks in the summer break after VI semester

EVALUATION PATTERN FOR COURSES 18AT2036, 18AT2037, 18AT2038 AND 18AT2039

The evaluation pattern is given below to get approval from the standing committee.

Total marks (100%)

1. Attendance	= 10 *
2. Internal assessment/Presentation	= 40
3. Evaluation of report	= 40
4. Viva-Voce examination	= 10
Total	= 100

(Note: *80% attendance is required for eligibility to award marks/grade)

AGRICULTURE

LIST OF COURSES

Sl. No.	Course Code	Name of the Course	Credits
1	17AG1001	Principles of Agronomy and Agricultural Heritage	3:0:1
2	17AG1002	Agricultural Microbiology	3:0:1
5	17AG1003	Fundamentals of Plant Biochemistry	3:0:1
6	17AG1004	Agricultural Meteorology	3:0:1
7	17AG1005	Irrigation Water Management	3:0:1
8	17AG1006	Crop Physiology	3:0:1
9	17AG1007	Principles of Genetics and Genomics	3:0:1
10	17AG1008	Principles of Agricultural Economics	3:1:0
11	17AG1009	Dimensions of Agricultural Extension	2:0:1
12	17AG1010	Principles of Horticultural Sciences	2:0:1
13	17AG1011	Introduction to Soil Science	3:0:1
14	17AT1001	Introduction to Agriculture	2:0:0

17AG1001 PRINCIPLES OF AGRONOMY AND AGRICULTURAL HERITAGE

Credits: 3:0:1

Course Objectives:

- To have a general understanding on the crops and their classification
- To apprise the student about planting of crops and application of fertilizers
- To familiarize the students with the traditional agricultural practices in the world

Course outcome:

- Basics of crop characteristics and classification understood
- Fundamentals of soil-water-plant relationship studied
- Best traditional practices learned

Description:

Meaning, definition and scope of agronomy. Relationship with other disciplines / divisions of agronomy- Classification of crop / plants based on the intensity of cultivation, uses, life span, growth habit, and climatic response and/or habitat. Agronomic classification of crops. Botanical classification. Category of cultivars - classification of crops based on special purpose. Growth - definition - factors affecting growth - Crop yield contributing characters - harvest index - Seed - definition - characteristics of good quality seed - vegetative propagation in field crops - setts, slips, tubers, and rhizomes - methods of sowing / planting - planting geometry and its effect on growth and yield - Tillage definition - objectives - types of tillage- tillage implements - tillage - characteristics of good tillage - Soil productivity and fertility- Crop nutrition - nutrients - classification - Nutrient sources - organic manures - fertilizers - biofertilizers - Integrated Nutrient Management Agricultural Heritage: history of agriculture in India - Traditional water lifting devices-best traditional water harvesting practices. Ancient irrigation structures in India-Water management during Indus valley civilization period and agriculture in Saptha saindhava.

Practical:

Visit to crop field and identification of crops- Study on field preparation: tillage implements - ploughs, harrows and cultivators - Practice of ploughing; Practice of puddling; Study of seeding equipment. Different methods of sowing crops-direct seeding: broadcasting, dibbling and drilling-transplanting. Identification of manures and fertilizers - organic manures: bulky and concentrated-fertilizers: Straight, complex and mixed fertilizers - Fertilizer recommendation and calculation of doses for rice, coconut, cassava, banana and cowpea. Methods of application of fertilizers broadcasting, placement, foliar application and fertigation - Visit to experimental plots to study design and layout - yield estimation of crops.

References:

1. Vishwakarma, A.K., Gopal Kumar, Brajendra, 2015, Agronomy A to Z, Biotech Books, New Delhi
2. Patil, J.V. et. al., 2015, Key Notes on Agronomy, Daya Publishing House, Delhi
3. Balasubramaniyan, P and Palaniappan, S.P. 2001. Principles and Practices of Agronomy. AgroBios (India) Ltd., Jodhpur
4. Brady, N.C. and Well, R.R. 2002. The Nature and Properties of Soils (13th ed.). Pearson Education, Delhi
5. De, G.C. 1989. Fundamentals of Agronomy. Oxford & IBH Publishing Co., New Delhi
6. Gupta, O.P. 2000. Weed Management - Principles and Practices. Agrobios (India) Ltd., Jodhpur
7. Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th ed.). Pearson Education, Delhi
8. KAU [Kerala Agricultural University]. 2016. Package of Practices Recommendations. Kerala Agricultural University, Thrissur
9. Rao, V.S. 2000. Principles of Weed science. Oxford & IBH Publishing Co. New Delhi
10. Reddy.T.Y and Reddy, G.H.S. 1995, Principles of Agronomy, Kalyani Publishers, Ludhiana
11. Reddy.S.R. 1999. Principles of Agronomy, Kalyani Publishers, Ludhiana
12. Sankaran, S. and Subbiah Mudaliar, V.T. 1991. Principles of Agronomy. The Bangalore Printing & Publishing Co., Bangalore
13. Thomas, C.G. and Abraham, C.T. 1998. Common Weeds of Rice Ecosystem and Their Management. Kerala Agricultural University, Thrissur
14. Thomas, C.G. and Abraham, C.T. 2007. Methods in Weed Science. Kerala Agricultural University, Thrissur

17AG1002 AGRICULTURAL MICROBIOLOGY**Credits: 3:0:1****Course Objectives:**

- To learn about germ theory of the diseases
- To have a general understanding on soil microbiology
- To study the beneficial use of micro-organisms

Outcome:

- Germ theory studied
- Action of microbes in soils understood
- Beneficial use of microbes learned

Description:

Introduction to microbial world - history of microbiology – Spontaneous generation theory – prokaryotic and eukaryotic microorganisms – bacterial cell - morphology and structure - germ theory of disease - protection against infections – applied areas of microbiology - metabolism in bacteria - ATP generation - chemoautotrophy, photoautotroph, respiration, fermentation – bacteriophages - structure and properties of bacterial viruses – lytic and lysogenic cycles - viroids, prions. Bacterial genetics – gene expression - genetic recombination - transformation, conjugation and transduction. Genetic engineering: plasmids, episomes - genetically modified organisms. Soil microbiology: microbial groups in soil - microbial transformations of carbon, nitrogen, phosphorus and sulphur - biological nitrogen fixation - microflora of rhizosphere and phyllosphere microflora - microbes in composting - microbiology of water; Microbiology of food: role of microbes in fermentation - microbial spoilage and principles of food preservation. Beneficial microorganisms in agriculture - biofertilizer (bacterial, cyanobacterial and fungal) - microbial insecticides - microbial agents for control of plant disease – biodegradation - biogas production - biodegradable plastics. Plant microbe interactions: beneficial – symbiotic, associative and non-symbiotic – PGPR – plant pathogens. Endomycophytic bacteria

Practical

Familiarization with instruments, materials, glassware etc. in a microbiology laboratory - practice of aseptic methods: I - evaluation of aseptic technique with nutrient broth tubes. II- evaluation of aseptic technique with a nutrient agar plate - methods of sterilization and preparation of media I- preparation of nutrient broth, nutrient agar plates, nutrient agar slant and nutrient agar stab; II- sterilization of glassware by dry heating; III - sterilization of

nutrient broth by filtration - plating methods for isolation and purification of bacteria I - isolation of bacteria by streak plate method. II - isolation of aerobic spore forming bacteria by enrichment using streak plate method. III - checking of purity of a bacterial culture by streak plating method - identification of bacteria by staining methods and biochemical tests: I- morphological examination of bacteria by simple and differential staining. II – different biochemical tests for identification of bacterial culture; enumeration of bacteria: I - enumeration of bacteria by stain slide method. II- enumeration of bacteria by most probable number method. III -enumeration of bacteria by pour plate method and spread plate method.

References

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3. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 1993. Microbiology. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
4. Stanier, R.Y., Ingraham, Wheelis, M.G. and Paintor, P.R. 1986. The Microbiology World. Prentice Hall, New Jersey.
5. Tauro, P., Kapoor, K.K. and Yadav, K.S. 1989. An Introduction to Microbiology. Wiley Publications, New Delhi.
6. Alexander, M. 1985. Introduction to Soil Microbiology. John Wiley & Sons, New York.
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8. Deepak Kumar Verma, Balaram Mohapatra, Shikha Srivastava, Sashi kanta Dash, Ajay Veer Singh, Bavita Asthir, Dinesh Narayan Bharadwaj, 2013, Objective Agricultural Microbiology at a Glance, First Edition, Scientific International (Pvt.) Ltd., Delhi

17AG1003 FUNDAMENTALS OF PLANT BIOCHEMISTRY

Credits: 3:0:1

Course Objectives:

- To impart knowledge on plant cells, proteins and biosynthesis
- To educate on the importance of proteins, enzymes and lipids
- To impart knowledge on biosynthesis

Course Outcome:

- Basic understanding imparted on plant cells, proteins, industrial applications and biosynthesis
- The students learnt the importance of plant cells
- Basics of protein enzymes and lipids understood
- Familiarized with the application of bio-molecules in industry

Description:

Biochemistry – introduction and importance. Plant cell, cell wall and its role in livestock, food and paper industries. Bio-molecules – Structure, properties and applications: Amino acids, peptides and proteins –Plant proteins and their quality. Enzymes –Factors affecting the activity, classification, immobilisation and other industrial applications. Lipids –Acyl lipids, their industrial application in soaps, detergents, paints, varnishes, lubricants, adhesives, plastics, nylon, bio-diesel, biodegradable plastics etc. Carbohydrates; Nucleotides and Nucleic acids. Metabolic energy and its generation – Metabolism – Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. General reactions of amino acid degradation. Biosynthesis – carbohydrates, lipids, proteins and nucleic acids. Metabolic regulation. Secondary metabolites, Terpenoids, Alkaloids, Phenolics and their applications in food and pharmaceutical industries.

Practical

Amino acid models (atomic); Paper electrophoresis for the separation of plant pigments; Protein denaturation – heat, pH, precipitation of proteins with heavy metals, Protein estimation by Lowry method; Enzyme kinetics, competitive inhibition, enzyme immobilization; Extraction of nucleic acids, column chromatography of RNA hydrolysate; Characterization of lipids by T.L.C.; Extraction of oil from oil seeds; Estimation of fatty acids by G.L.C.; Models of sugars, sucrose and starch; Quantitative determination of sugars; Paper chromatography for the separation of sugars; Determination of phenols.

References

1. Dutcher, Raymond Adams et. al., 2014, Biotech Books, New Delhi
2. Chavan, U. D., Patil, J. V., 2015, Key Notes on Biochemistry and Biotechnology, Daya Publishing House, Delhi
3. Conn, E.E and Stumpf, P.K. 1989. Outline of Biochemistry. Wiley Eastern Ltd., New Delhi.
4. Frank M. Mallette, Paul M. Althouse and Carl O. Glagett. 1960. Biochemistry of Plants and Animals. Published by Wiley Pvt Ltd., New Delhi
5. Jain, J.L. 2001. Fundamentals of Biochemistry. 5th Edn., S.Chand & Company, New Delhi
6. Lehninger, A. 1984. Principles of Biochemistry. Published by CBS Publishers and Distributors, New Delhi
7. Mazur, A and Harrows, B. 1971. Textbook of Biochemistry. W.B. Sanders Publications, New Delhi
8. Metha, S.L, Lodha, M.L and Sane, P.V. 1993. Recent Advances in Plant Biochemistry. ICAR, New Delhi
9. Hans-Walter Heldt ,2005, Plant biochemistry, Academic Press

17AG1004 AGRICULTURAL METEOROLOGY

Credits: 3:0:1

Course Objectives:

- To understand the role of meteorology in plant science
- To learn climatic parameters and their measurements
- To study the fundamentals of global warming and climate change

Course Outcome:

- Agro-climatic factors understood
- Measurement and estimation techniques for climatic parameters learned
- Fundamentals of global warming and climate change studied

Description:

Introduction to meteorology and agricultural meteorology - Scope and importance of agricultural meteorology - Composition of atmosphere - role of greenhouse gases in global cooling and warming - concept of weather and climate - Micro-meso-macro and phyto climates - Electromagnetic spectrum. Nature and properties of solar radiation - shortwave radiation and long wave radiation – Radiation balance - response of plants to solar radiation and photosynthetically active radiation - Thermal structure of atmosphere - vertical profiles - factors affecting surface air temperature - spatial and temporal variations in surface air temperature - soil temperature and its variations. Atmospheric pressure and its variation with height - global distribution of pressure and wind - atmospheric humidity - saturation and actual vapour pressure - relative humidity and dew point temperature. Cloud classification and measurements - cloud seeding - Rainfall and its mechanisms - forms and types of rainfall – Indian monsoons - southwest monsoon - northeast monsoon - monsoon variability across Tamil Nadu and India - Rainfall over India and Tamil Nadu- Importance of weather forecasting in agriculture - weather service to farmers - agricultural seasons - crop weather diagrams and calendars – crop weather relationships. Role of weather on insect pest and diseases - weather and climate related natural disasters, risk and management - Climate change and global warming - weather modification - Introduction to remote sensing.

Practical:

Meteorological and agrometeorological stations - Types of agricultural meteorological stations - Selection of site and layout of agro meteorological stations - Measurement of atmospheric variables - Air temperature and soil temperature - Relative humidity - Determination of vapour pressure - Measurement of wind speed and direction - Measurement of rainfall and open pan evaporation - Installation of soil thermometers and measurement - sunshine recorder and measurement of sunshine duration - Automatic Weather Station - recording of weather data - tabulation - processing and presentation - Preparation of crop weather calendars.

References:

1. Khanna, D R et al, 2013, Climate Change Effects on Agriculture and Economy, Biotech Books, New Delhi
2. Das.P.K. 1968. The Monsoons. NBT, New Delhi
3. Khadekar, S.R. 2001. Meteorology. Agromet Publishers, Nagpur
4. Mavi, H.S. 1986. Introduction to Agrometeorology. Oxford & IBH Publishing Co. New Delhi
5. Menon, P.A. and Rajan, C.K. 1989. Climate of Kerala. Classic Publishing House, Kochi

6. Prasada Rao, G.S.L.H.V. 2005. Agricultural Meteorology. Second Edition. Kerala Agricultural University, Thrissur.
7. Sachati, A.K. 1985. Agricultural Meteorology – Instruction-cum-practical manual, NCERT, New Delhi
8. Varshney, M.C. and Balakrishna Pillai, B. 2003. Textbook of Agricultural Meteorology. ICAR, New Delhi.
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10. Wilsie, P.C. 1961. Crop Adaptation and Distribution. Eurasia Publishing House (P) Ltd., New Delhi

17AG1005 IRRIGATION WATER MANAGEMENT

Credits: 3:0:1

Course Objectives:

- To introduce soil-water-plant relationships in the context of irrigation
- To introduce the concepts of scheduling, water distribution, design and methods of irrigation
- To have practical knowledge on drip and sprinkler irrigation

Course Outcome:

- Students learnt estimation of crop water and irrigation requirements
- Students enabled in implementing irrigation schemes
- Students capacitated in selecting appropriate irrigation methods

Description:

Irrigation: need, importance, impact on development of humanity, development in India; National Water Policy and irrigation. Canal, tank irrigation. Crop water requirement of different crops; infiltration; soil-water-plant relationships; soil quality; Duty of water; supply and demand based water distribution; irrigation scheduling; frequency and interval of irrigation; Warabandhi system. Different irrigation methods: border irrigation, furrow irrigation, basin irrigation, drip and sprinkler irrigation; irrigation methods: consideration of slope, soils and climate, evaluation, wetting pattern and planting techniques, efficiency; case studies.

Practicals

Visit to farm and demonstration of basin, drip and sprinkler irrigation in the field; conducting pumping test; planning, design and estimation related to drip irrigation.

Reference

1. Lamm, Freddie R., et. al., 2013, Microirrigation for Crop Production: Design Operation and Management, Bio-Green Elsevier (Exc)
2. Majumdar D. P., 2005, Irrigation Water Management: Principles and Practices, Prentice Hall of India, New Delhi
3. Dewasish Choudhary, 2008, Irrigation Theory and Practice, Anmol Publications Pvt Ltd
4. Michael A.M., 1999, Irrigation Theory and Practice, Vikas Publishing House, New Delhi
5. Van den Bosch B.E., Hoevenaars J. and Broumer C., 1999, Irrigation Water Management Training Manual, No.1 to 7, FAO, Rome.
6. Asawa G.L., 1996, Irrigation Engineering, New Age International Private Limited, New Delhi.

17AG1006 CROP PHYSIOLOGY

Credit 3:0:1

Course Objectives:

- To introduce the students to seed physiology and biochemical changes during seed development.
- To understand growth and growth characteristics
- To impart knowledge on basic nutriophysiology

Course Outcome:

- Knowledge gained on different aspects of seeds
- Study growth pattern of plants
- Learned nutriophysiology

Description:

Seed physiology, seed structures - morphological, physiological and biochemical changes during seed development - physiological maturity, harvestable maturity, seed viability and vigour. Methods of testing seed viability and vigour, germination, utilization of seed reserves during seed germination. Morphological, physiological and biochemical changes during seed germination. Measurement of growth, growth analysis growth characteristics. Crop water relations. Transpiration - significance. Photosynthesis, energy synthesis, photosynthetic efficiency, photorespiration. Brief account of growth respiration and maintenance respiration, alternate respiration. Physiology of nutrient uptake – functions of plant nutrients – deficiency and toxicity symptoms of plant nutrients – foliar nutrition – hydroponics. Post harvest physiology – Factors influencing seed storage (ISTA standards). Fruit ripening - metamorphic changes – climateric and non-climateric fruits.

Practicals:

Study of plant cells; Preparation of standard solutions; Structure and distribution of stomata, imbibition, osmosis and plasmolysis, measurement of root pressure, rate of transpiration; Separation of photosynthetic pigments through paper chromatography; Estimation of chlorophyll; Rate of transpiration; Photosynthesis, respiration, tissue test for mineral nutrients; Estimation of RWC; Measurement of rate of photosynthesis by IRGA; Estimation of hormone using bioassay.

References

1. Singh, Amrit Lal, Recent Advances in Crop Physiology (Vol.1), 2014, Daya Publishing House, Delhi 2014
2. Devlin R.M. 1979. Plant Physiology, II Edn, Affiliated East West Press, New Delhi
3. Noggle G.R. & Fritz G.J. 1992. Introductory Plant Physiology, II Edn. Prentice Hall of India (P) Ltd., New Delhi
4. Milthorpe, F.L. and Marby, J. 1979. An Introduction to Crop Physiology, Cambridge University Press, London
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7. Malick, C.P and Srivastava, A.K.. 2000, Text book of Plant Physiology, Kalyani Publishers, New Delhi.
8. Taiz, Land Zeiger, E. 2014. Plant Physiology. Sinauer Associates Publishers Inc., Publishers

17AG1007 PRINCIPLES OF GENETICS AND GENOMICS

Credits 3:0:1

Course Objectives:

- To impart knowledge on structure of genes and type of genes action
- To make the student understand chromosome, structure, morphology, number and types
- To learn basics of DNA, RNA and fundamentals of transcription, translation, genetic code and outline of protein synthesis

Course Outcome:

- Mendel's laws and types of gene action studied
- Basics of DNA, RNA and fundamentals of transcription, translation, genetic code and protein synthesis learned, as also evolution of different crop species understand
- Chromosomal aberrations and evolutions of different crop species studied

Description:

Mendel's laws of inheritance and exceptions to the laws. Types of gene action, Multiple alleles, Pleiotropism, Penetrance and expressivity; Quantitative traits and Qualitative traits. Multiple factor hypothesis: cytoplasmic inheritance – important features and difference from chromosomal inheritance. Mutation and it's features; Methods of inducing mutations and CIB technique. Fine structure of gene; gene expression regulation and differential gene activation; Ultra structure of cell and cell organelles and their functions. Study of chromosome structure - morphology, number and types, Karyotype and Idiogram; Mitosis and meiosis - their significance and differences. DNA - its structure and function – types of DNA – modes of replication and repair. RNA - its structure, function and types; transcription, translation, genetic code and outline of protein synthesis. Linkage and crossing: types of linkage, over estimation of linkage; Numerical chromosomal aberrations (Polyploidy) and evolution of different crop species like cotton, wheat, tobacco, triticale and brassicas. Structural chromosomal aberrations.

Practicals:

Microscopy-Preparation and use of fixatives and stains for light microscopy; Preparation of micro slides and identification of various stages of mitosis and meiosis; Monohybrid ratio and its modifications; Dihybrid ratio and its

modifications; Trihybrid ratio; Chisquare analysis, Interaction of factors; Epistatic factors, Supplementary factors and duplicate factors; complementary factors; additive factors and inhibitory factors.

References:

1. Singh, Upadhyaya Bisht, 2015, Genetic and Genomic Resources of Grain Legume Improvement, Elsevier-Biogreen
2. Sharma, Ramnivas, 2006, Agricultural Science: Gene Sequencing and Mapping, Biotech Books, New Delhi
3. Acquaah, G. 2007. Principles of Plant Genetics and Breeding, Blackwell Publishing Co., New Delhi
4. Gardner, J., Simmons, M. J. and Snustad, D. P. 2009. Principles of Genetics (8th Ed.). Wiley India Pvt. Ltd., New Delhi.
5. Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
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7. Pierce, B. A. 2014. Genetics - A Conceptual Approach, W.H. Freeman & Company, California
8. Singh, B.D. 2000. Fundamentals of Genetics (6th Ed.). Kalyani Publishers, Ludhiana
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11. Strickberger, M.W.1996. Genetics (3rd Ed.). Mc Millan Publishing Co., New Delhi.
12. Swanson, C.P., Merz, T. and Young, J. 1975. Cytogenetics. Prentice Hall of India Pvt. Ltd., New Delhi.
13. Winchester, A.M.1967. Genetics (3rd Ed.). Oxford and IBH Publishing Co., New Delhi.

17AG1008 PRINCIPLES OF AGRICULTURAL ECONOMICS

Credits: 2:1:0

Course Objectives:

- To highlight the importance of agricultural economics
- To familiarize with different theories and laws in economics applicable to agriculture
- To learn the basics of public finance and welfare economics in relation to agriculture

Course Outcome:

- Basics of agricultural economics and fundamentals of welfare economics studied
- Theories and laws applicable to agriculture economics learned
- Gained knowledge on public finance and welfare economics in relation to agriculture

Description:

Economics: Meaning, definition, subject matter. Divisions of economics -importance of economics. Agricultural economics - meaning, definition- Basic concepts -goods, service, utility, value, price, wealth, welfare. Wants - meaning, characteristics, classifications of wants, importance. Theory of consumption; Law of diminishing marginal utility: meaning, definition, assumption, illustration, limitations, law of equimarginal utility-importance. consumer surplus: meaning, definition, importance. Demand: meaning, definition, kinds of demand, demand schedule, demand curve, law of demand, extension and contraction vs increase and decrease in demand. Elasticity of demand: types of elasticity of demand, degrees of price elasticity of demand, methods of measuring elasticity, factors influencing elasticity of demand, importance of elasticity of demand. Supply: meaning, supply function-law of supply - factors influencing Production: meaning, factors of production- land, labour, capital, organization, entrepreneurship.- Distribution: rent, wages, interest, profit. National income: definition and concepts. Public finance: meaning. Public resource: meaning – sources. Taxation types; Public expenditure: meaning, principles, Money: meaning – evolution. Inflation: definition, types of inflation.- Welfare economics: meaning and basic concepts.

References:

1. Sharma, Pawan Kumar, Dwivedi, Sudhakar, Bhat, Anil, 2014, Practicals in Agricultural Economics, Daya Publishing House, Delhi
2. Chavan, U.D. et. al., 2015, Key Notes on Agricultural Economics, Business Management and Statistics (PB), Daya Publishing House, Delhi
3. Dewett, K.K. 2005. Modern Economic Theory. S. Chand, New Delhi.
4. Dewett, K.K., Verma. 2004 Elementary Economic Theory, S.Chand, New Delhi

5. Jhingam, M.L. 2001. Micro Economic Theory. Konark Publishers, New Delhi
6. Kenneth, E.B. 1941. Economic Analysis. Harper and Row, New York.
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17AG1009 DIMENSIONS OF AGRICULTURAL EXTENSION

Credits: 2:0:1

Course Objective:

- To orient the students with the concept of extension education and its importance in agriculture development
- To expose the students with various rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis
- To make the students learn about the new innovations being brought into the Agricultural Extension in India

Course Outcome:

- Students learned the concepts of agricultural extension and rural development programs
- New innovations in the area of agricultural extension in India understood
- Gained practical knowledge on watershed development and self-help groups

Description:

Education: meaning, definition, types. Formal, Informal and Non-formal education and their characteristics. Extension Education and Agricultural Extension: meaning, definition, concepts, objectives and principles. Rural development: meaning, definition, concepts, objectives, importance and problems in rural development. Developmental programmes of pre-independence era - Sriniketan, Marthandam, Gurgaon experiment and Gandhian constructive programme. Development programmes of post-independence era, Firka Development, Etawah- Pilot project and Nilokheri Experiment. Community Development Programme: meaning, definition, concepts, philosophy, principles, objectives, differences between community development and extension education. National Extension service. Panchayat Raj system: meaning of Democratic Decentralization and Panchayat Raj, Three tiers of Panchayat Raj system: power, functions and organizational setup. Agricultural Development Programmes with reference to year of start, objectives and salient features - Intensive Agricultural District Programme (IADP), High Yielding Varieties Programme (HYVP), Institution Village Linkage Programme (IVLP), Watershed Development Programme (WDP), National Agricultural Technology Project (NATP), ATMA, ATIC, Social Justice and Poverty alleviation programmes, Integrated Tribal Development Agency (ITDA), Integrated Rural Development Programme (IRDP), Swarna Jayanti Gram Swaraj Yojana (SGSY), Prime Minister Employment Yojana (PMEY). New trends in extension, privatization. Women Development programmes Development of Women and Children in Rural Areas (DWCRA), Rashtriya Mahila Kosh (RMK), Integrated Child Development Scheme (ICDS) and Mahila Samridhi Yojana (MSY). Reorganized extension system (T & V System)- Salient features, Fort night Meetings, Monthly workshops, Linkages: merits and demerits. Emergence of Broad Based Extension (BBE).

Practicals:

Visits to a village and kisan mandal to study the ongoing development programmes. Visits to Panchayat Raj Institutions to study the functioning of Gram Panchayats (GP) and Zilla Praja Parishad (ZPP). Visit and study the District Rural Development Agency (DRDA). Participation in monthly workshops of Training and Visit (T&V) System. Visit to Watershed Development Project area. Visit to a village to study the Self Help Groups (SHGs) of DWCRA. Visit to a voluntary organization to study the developmental activities. Organizing PRA techniques in a village to identify the agricultural problems. Visit to villages.

Reference:

1. Singh, Vir et. al., 2015, Extension for Agriculture and Rural Development, Biotech Press
2. Singh, Ashok K, 2014, Extension Strategies for Agriculture and Rural Development, Daya Publishing House, Delhi
3. Dileep Kumar, Khajan Singh, 2012, Agricultural Extension: Innovations and Dimensions, Satish Serial Publishing House
4. Patel, M.M., Badodya, S. K., Gujpta, Shobhana, 2014, Participatory Approaches for Transfer of Agricultural Technology, Biotech Books, New Delhi
5. Singh A.K. et. al., 2015, Dynamics of Agricultural Extension Approaches, Biotech Books, New Delhi

6. O.P.Dahama & O.P. Bhatanagar, 2014, Education and Communication for Development, Oxford & Ibh Publishing Co Pvt Ltd

17AG1010 PRINCIPLES OF HORTICULTURAL SCIENCES

Credits 3:0:1

Course Objectives:

- To teach fundamentals of horticulture and horticultural practices
- To impart knowledge on different types of plant propagation and also structures used in farms
- To expose the students to different horticulture vegetables, fruits, species, aromatic and medicinal crops

Course Outcome:

- Fundamentals of horticulture and classification of crops learned
- Different types of plant propagation techniques and structures used in the farm studied
- Gained practical knowledge in plant propagation and pest and disease control

Description:

Horticulture, vegetables, fruits, spices, aromatic and medicinal plants and floriculture, plantation crops, tuber crops, bamboo and mushroom - definition, evolution, art, science, vocation, hobby, etc. Importance, divisions, classification of crops; Commercial orchards, garden and plantations. Selection of site for crops - climate, soil, socio-economic factors; Orchard planning, layout, peg marking, planting systems, spacing, digging pits, age of planting materials, after care, inter cropping, mixed cropping, etc. Tree forms and functions training and pruning in horticultural crops, principles and methods. Techniques of training and pruning – root pruning, girdling, ringing, notching, smudging, and bending, thinning - chemical and mechanical. Phases of growth and development: vegetative / reproductive balance; flowering, bearing habit and its classification; Fruit set - carbon nitrogen relation, structure and process in relation to set and drop, factors affecting and measures to overcome drop; Problems of unfruitfulness - internal factors, external factors – measures to overcome; Seedlessness in horticultural crops - significance and induction; Plant growth regulators in horticulture - natural and synthetic regulators - preparation and methods of application; Plant propagation - definition and basic concepts, types - advantages and disadvantages; Potting and repotting - objectives and uses, containers and potting media/ mixture - kinds, qualities, pre-planting treatments; Propagation by seed - seed qualities, seed testing, seed germination - types of seed dormancy, pre-sowing treatments – factors affecting germination. Asexual propagation - apomixis, polyembryony, plant modifications for vegetative propagation - bud sports, chimeras. Propagation by cuttings - types of cuttings - factors affecting rooting of cuttings. Propagation by layering - advantages and disadvantages -types of layering. Propagation by grafting - advantages and disadvantages, stock - scion relationships, incompatibility; Grafting and budding - methods - advantages and disadvantages - separation and after care; Plant propagating structures - green house/ glass house, hot bed, cold frame, lath house, net house, mist chamber; Nursery - site selection, lay-out, components, progeny orchards, sales unit, display area, management, maintenance, commercial propagation of selected horticultural plants; Micro propagation of horticultural plants - definition, principles, methods, advantages and disadvantages, field of application in horticultural crops.

Practicals

Practice in propagation of plants through seeds. Familiarization with media , implements and containers for plant propagation. Studies on seed testing, certification and storage. Practice in rootstock production, vegetative propagation methods – cutting, budding, grafting layering etc. separation of propagules. Use of growth regulators for plant propagation. Study of propagation through tissue culture. Studies on preparation of designs and estimates for establishment of plant propagation unit, plant growing structures and tissue culture unit. Identification of common pests and diseases in nursery plants and their control. Visit to different types of nurseries, selection of site and layout– Familiarization with components of nurseries– handling, display and sales of plants – cultural practices – Estimation of production costs for different kinds of planting materials. Practice of potting /bagging, re-potting etc. Packing and transport of nursery materials. Practice in tissue culture laboratory. Registers to be maintained in a commercial nursery. Visit to different nurseries (both government and private).

References:

1. Misra Kaushal Kumar, 2016, Practical Manual of Horticulture, Biotech Press
2. Sharangi, Amit Baran, 2014, Seed Production of Selected Horticultural Crops, Regency Publications
3. Chavan, U. D. et. al., 2015, Key Notes on Horticulture and Agriculture Extension, Daya Publishing House, Delhi

4. Kaleeshwari R. K., Latha M. R., Rajeswari R., 2013, Compendium of Objective Soil Science, Satish Serial Publishing House
5. Bose, T K., Mitra, S K. and Sadhu, K. 1986. Propagation of tropical and subtropical horticultural crops. Naya Prokash, Calcutta
6. Christopher, E P. 1958. Introductory Horticulture. Mc Graw Hill, New Delhi
7. Denixon, R I. 1979. Principles of Horticulture. Mac Millan, New York
8. Edmond, J B., Sen, TD, Andrews, T S and Halfacre, R G. 1977. Fundamentals of Horticulture. Tata Mc Graw Hill, New Delhi
9. Halfacre, R G. and Barden, J A. 1979. Horticulture. Mc Graw Hill, New Delhi
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11. Janick, J. 1963. Horticultural Science. W.H. Freeman, Sanfrancisco
12. Kumar, N. 1990. Introduction to Horticulture, Rajalekshmi Publication, Nagercoil
13. Leopold, A.C. and Kriedeman, P.E. 1975. Plant Growth and Development. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
14. Thorpe, T.A. 1981. Plant Tissue Culture: Methods and Application in Agriculture. Academic Press, New York
15. Sheela, V.L. 2011. Horticulture. MJP Publishers, Chennai
16. Peter, K. V. 2014, Basics of Horticulture. New India Publishing Agency, New Delhi.
17. Singh, J. 2002. Basic Horticulture, Kalyani Publishers, Ludhiana

17AG1011 INTRODUCTION TO SOIL SCIENCE

Credits: 3:0:1

Course Objectives:

- To highlight the physical properties of soils
- To understand soil-water interaction and thermal properties of soil
- To study the chemical and biological aspects of soil

Course Outcome:

- Students made familiar with the role of soils in agriculture
- Familiarized with physical, chemical, biological aspects of soil and soil-water-plant interaction
- Learned soil biology including the beneficial and harmful role of soil organism

Description:

Soil-Pedological and edaphological concepts -origin of the earth - earth's crust - composition. Rocks and minerals. Weathering - soil formation - factors and processes - components of soils -soil profile. Soil physical properties - soil texture - textural classes - particle size analysis. Soil structure classification - soil aggregates – significance. Soil consistency - soil crusting. Bulk density and particle density of soils and porosity – their significance and manipulation. Soil compaction - soil colour. Elementary knowledge of soil classification. Soils of India - geological formations – characterization of soils of Tamil Nadu. Soil water - retention and potentials - soil moisture constants - movement of soil water – infiltration – percolation – permeability – drainage - methods of determination of soil moisture. Thermal properties of soils - soil temperature - soil air - gaseous exchange - influence of soil temperature and air on plant growth. Soil colloids – properties – nature - types and significance. Layer silicate clays - their genesis and sources of charges. Adsorption of ions - ion exchange - CEC and AEC - factors influencing ion exchange and its significance. Concept of pH - soil acidity – brief overview of saline, sodic and calcareous soils. Soil organic matter – composition – decomposability – humus - fractionation of organic matter. Carbon cycle - C: N ratio. Soil biology – biomass - soil organisms and their beneficial and harmful roles.

Practical

Determination of bulk density and particle density - aggregate analysis - soil strength. Soil moisture determination - soil moisture constants – field capacity - infiltration rate - water holding capacity. Soil texture and mechanical analysis. Soil temperature. Analytical chemistry – basic concepts - techniques and calculations. Collection and processing of soil for analysis – organic carbon, pH, EC, - Study of a soil profile – Identification of rocks and minerals. Total elemental analysis of soils. Estimation of CEC.

References

1. Millar, Charles Ernest, Turk L M, 2013, Fundamentals of Soil Science, Biotech Press

2. Biswas, T.D. and Mukherjee, S.K. 1987. Text Book of Soil Science. Tata McGraw Hill Publishing Co., New Delhi
3. Brady, N.C. 1990. Nature and Properties of Soils. 10th Edn, Macmillian Publishing Co. Inc., New York
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5. Foth, H.D. and Turk, L. M. 1972. Fundamental of Soil Science. 5th Edn. Wiley Eastern Pvt. Ltd., New Delhi
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8. Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edn. Kalyani Publishers, Ludhiana
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17AT1001 INTRODUCTION TO AGRICULTURE

Credit: 2:0:0

Course Objectives:

- To introduce the scope of agriculture to engineering students
- To impart knowledge on soil-water-plant relationship
- To familiarize with plant growth and fertilizer application and irrigation

Course Outcome:

- Basics of agriculture science learned
- Soil-water-plant relationship learned
- Different stages of plant growth and application of fertilizers studied

Description:

Orientation to agriculture and agricultural engineering. Soils: Nature and origin of soil; soil forming rocks and minerals, soil forming processes, important soil physical properties and their importance. Ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility. Soil reaction – acid, saline and sodic soils. Agronomy: Definition and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. Principles of tillage, tillage and its characteristics. Soil water plant relationship and water requirement of crops. Soil fertility and its management, integrated nutrient management. Bio-fertilizers and vermin composting. Weeds and their control, integrated weed management. Crop rotation, cropping systems, relay cropping and mixed cropping. Sustainable agriculture, integrated farming system, precision farming, organic farming and good agricultural practices. Horticulture: Scope of horticultural and vegetable crops. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, criteria for site selection, layout and planting methods, nursery raising, macro and micro propagation methods, plant growing structures, pruning and training, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post-harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds.

References:

1. Sharma, Rakesh Kumar et. al., 2014, Basics of Agriculture for Engineers, Daya Publishing House, Delhi
2. Gajendra Singh Tomar, 2010, Agronomy: Basic and Applied, Satish Serial Publishing House
3. Bose, T.K and S.K. Mitra. 1990. Fruits, Tropical and Subtropical. Naya Prakash, Calcutta.
4. Brady, Nyle C. 1988. The Nature and Properties of Soils. Eurasia Publishing House Pvt Ltd, New Delhi.
5. Das, P.C. 1993. Vegetable Crops of India. Kalyani Publishers, New Delhi.
6. De, G.C. 1989. Fundamentals of Agronomy, Oxford & IBH Publishing Co Pvt Ltd, New Delhi.

LIST OF NEW COURSES

S.No.	Course Code	Name of the Course	Credits
1	18HO2012	Study Tour – I	0:0:1
2	18HO2013	Principles of Ornamental Horticulture and Landscape Architecture	2:0:1
3	18HO2014	Dryland Horticulture	2:0:1
4	18HO2015	Breeding of Fruits and Plantation Crops	2:0:1
5	18HO2016	Seed Production of Vegetable, Tuber and Spice Crops	2:0:1
6	18HO2017	Insect Pests of Vegetable, Ornamental and Spice Crops	2:0:1
7	18HO2018	Introduction to Major Field Crops	1:0:1
8	18HO2019	Economics and Marketing	2:0:1
9	18HO2020	Horti-Business Management	2:0:0
10	18HO2021	Post-harvest Management and Processing of Horticultural Crops	2:0:2
11	18HO2022	Breeding and Seed Production of Flower and Ornamental Plants	2:0:1
12	18HO2023	Nematode Pests of Horticultural Crops and their Management	1:0:1
13	18HO2024	Apiculture, Sericulture and Lac Culture	1:0:1
14	18HO2025	Study tour - II	0:0:1

18HO2012 STUDY TOUR – I

Credits 0:0:1

Course Objectives

- To be familiar with various horticultural institutions/ Research Stations/ Colleges in South India
- To be familiar with the ongoing horticultural research and extension programmes in various Horticultural Institutions/ Colleges of South India

Course Outcome

At the end of this course, the students will be able to

- Gain practical knowledge about horticultural crops and cropping systems in the different agro-climatic zones and horticultural crops in Tamil Nadu
- Learn social, cultural aspects of different agricultural zones in TamilNadu
- Identify and analyze different soil types and cropping systems for horticultural crops in Tamil Nadu

Course Content:

The study tour programme is of one week, during this period various Agricultural Research Stations, Institutions or Colleges will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State.

Evaluation and mark distribution

In the study tour programme, full attendance is mandatory for a pass as per the ICAR regulations.

The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

18HO2013 PRINCIPLES OF ORNAMENTAL HORTICULTURE AND LANDSCAPE ARCHITECTURE

Credits 2:0:1

Course Objective

- To define scope and importance of ornamental horticulture and landscaping
- To familiarize with the different styles and designs of landscape architecture
- To learn about suitability of ornamental crops for different areas, cut flowers and floral arrangements
- To be able to use AutoCAD and ArchCAD for gardening and landscape designing

Course Outcome

At the end of this course, the students will be able to

- Remember the principles of landscape design
- Explain about the different ornamental crops and its landscape uses
- Develop knowledge about the crops suitable to different landscapes
- Discover different landscaping designs and architectures

Theory

History, definitions, scope, Importance, area and production, industrial importance of ornamental plants and flowers. Importance, classification, design values of ornamentals. Principles of Landscape gardens. Historical Importance of Indian gardens(English garden , Japanese gardens , Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens), Famous gardens of India and abroad, formal, informal, free style and wild gardens. Importance, design and establishment of garden features, bridges, paths, drives, fences, garden walls, gates, carpet bed, arbour, Patio, decking, retainingwalls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools,waterfalls, fountains, bog garden, avenue planting and children garden. Lawn types, establishmentand maintenance. Importance of flower arrangement, Ikebana techniques and types, uses of vertical garden, bottle garden, terrariums, xeriscaping, bonsai making and maintenance. Use of Auto CAD and Arch CAD in designing gardens. Factors affecting landscape design. Bio-aesthetic planning. Planning and designing of different gardens.

Practical

Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns. Palms, cycads, Cacti and succulents. Planning and designing and establishment of garden features viz. lawn, hedge, edge, rockery, water garden, carpet bedding, shade garden, roof garden, terrariums, verticalgarden, study and practice of different types of flower arrangements, floral bouquets, floral rangoli, veni etc., Study of Bonsai techniques, Bonsai practicing and training.Visit to nurseries and floriculture units. Study of garden equipments and designing of different styles of garden. Designing gardens using Auto-cad/archi-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, temples, churches, play grounds, corporate buildings/ malls. Visit to public, institutional and botanical gardens.

References:

1. De. L.C.Nursery and landscaping.2013. Pointer publishers, Jaipur India.
2. Grewal H.S and Parminder Singh. 2014. Landscape designing and ornamental plants
3. Peter. K.V.2009.Ornamental plants. New India publishing agency, Pitampura, New Delhi.
4. Rajesh Srivastava. 2014. Fundamentals of Garden designing. Agrotech press, Jaipur, New Delhi.
5. Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries pvt. Ltd.
6. Roy R.K. Fundamentals of Garden designing.2013.New India publishing agency, Pitampura, New Delhi.
7. Tiwari A.K and R. Kumar. 2012. Fundamentals of ornamental horticulture and landscape gardening. New India.

18HO2014 DRYLAND HORTICULTURE

Credits: 2:0:1

Course Objectives

- To learn about techniques and management of dryland horticulture
- To learn about the various water conservation methods
- To learn about horticultural crops adapted for dryland cultivation and special cultivation techniques

Course Outcome

At the end of this course, the students will be able to

- Remember the present day water availability scenario
- Explain different water conservation techniques
- Gain knowledge on different crops suitable to dryland areas
- Identify different dryland farming techniques

Theory

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encountered in dry lands. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc. Techniques and management of dry land horticulture. watershed development, soil and water conservation methods-terraces, contour bunds, etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits, etc., *in-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc. water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc. Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical

Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.

References

1. Awasthi O.P., P.L. Saroj. 2008. Advances in Arid Horticulture. Production Technology of Arid and Semiarid Fruits. International Book Distributing Co.
2. Chundawat, B.S. 1990. Arid Fruit Culture. Oxford and IBH, New Delhi.
3. Pradeep Kumar, T., B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. Management of Horticultural Crops. New India Publishing Agency.
4. Sivamurugan, A.P., R. Arun Kumar. 2008. Dryland Horticulture. Kalyani Publishers.
5. Taroj, P.L., B.B. Vashishtha, D.G.Dhandar. 2004. Advances in Arid Horticulture. Internal Book Distributing Co., Lucknow.

18HO2015 BREEDING OF FRUITS AND PLANTATION CROPS

Credits 2:0:1

Course Objectives

- To learn about fruit breeding and its importance in fruit production
- To be familiar with the various fruit crop improvement strategies
- To understand the breeding methods of important fruit and plantation crops

Course Outcome

At the end of this course, the students will be able to

- Remember the different breeding aspects in important fruit and plantation crops
- Explain about the different crop improvement strategies
- Develop knowledge about breeding methodologies of important fruit and plantation crops

Theory

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistachnut, Apple, Pear, Plum, Peach, Apricot and Strawberry.

Reference:

1. Anil Kumar Shukla 2004. Fruit breeding approaches & Achievements. International Book Distributing Co.
2. Kumar N. 2015. Breeding of Horticultural Crops: Principles and Practices 2nd Revised & Expanded Ed. New India Publishing Agency.
3. Ramachandra R.K., Maheshwar D.L., Shoba N. 2016. Breeding Of Spice & Plantation. Jaya Publishing House.
4. Gyana Root, Peter K.V. 2018. Genetic Engineering of Horticultural Crops. Academic Press. Elsevier. US.

18HO2016 SEED PRODUCTION OF VEGETABLE, TUBER AND SPICE CROPS

Credits 2:0:1

Course Objectives

- To learn about the history and growth of seed industry in India
- To learn about the various seed production techniques of important vegetable, tuber and spice crops
- To be familiar with the seed legislative laws in India

Course Outcome

At the end of this course, the students will be able to

- Remember the different seed production techniques
- Understand the different seed legislative laws
- Develop knowledge about the seed production techniques in important vegetable, tuber and spice crops

Theory

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy

vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

References:

1. Agarwal, P. K. 2010. Techniques in Seed Science and Technology. South Asian Publishers. New Delhi.
2. Arya, Prem Singh. 2003. Vegetable seed Production Principles. Kalyani Publishers. Ludhiana.
3. Fageria, M. S. 2011. Vegetable Crops- Breeding and Seed Production. Kalyani Publishers. Ludhiana.
4. Geetharani, P. 2007. Seed Technology in Horticultural Crops. NPH Publications. Jodhpur.
5. Hazra P. and Som M.G., 2009. Vegetable seed production and Hybrid Technology. Kalyani Publishers, Ludhiana.
6. Prem Singh Arya, 2003. Vegetable breeding, production and seed production. Kalyani publishers, New Delhi.
7. Singh, Prabhakar. 2015. Seed Production Technology of vegetable. Daya Publishing House. New Delhi.
8. Singh, S.P. 2001. 1st edition, *Seed production of commercial vegetables*. Agrotech Publishing, Udaipur
9. Vanangamudi, K. 2010. Vegetable Hybrid Seed Production and Management. Agrobios. Jodhpur.
10. Peter K.V. 2012 Handbook of Herbs & Spices. Woodhead Publishing. Elsevier. Cambridge. UK.

18HO2017 INSECT PESTS OF VEGETABLE, ORNAMENTAL AND SPICE CROPS

Credits 2:0:1

Course Objectives

- To learn about the insect pests of vegetable, ornamental and spice crops
- To study the ecology and integrated pest management strategies of important vegetable, ornamental and spice crops
- To assess damage, insecticidal residue, and tolerance limits of chemical pesticides in vegetable crops

Course Outcome

At the end of this course, the students will be able to

- Remember the major insect pests of vegetable, ornamental and spice crops
- Identify the different storage pests and their management
- Gain knowledge in Integrated Pest Management techniques of vegetable, ornamental and spice crops

Theory: Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host range, bioecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical

Study of symptoms, damage, collection, identification, preservation, assessment of damage/ population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

References:

1. Emmanuel, N, A. Sujatha, T.S.K. K. Kiran Patro, MLN Reddy, B. Srinivasulu, TSSK Samuel Patro. 2015. Text Book on Integrated Pest Management of Horticultural Crops Astral International Publishers, New Delhi.

2. Dhalinal G.S. and Ramesh Arora Integrated Pest Management Concept and Approaches. Kalyani Publishers, Ludhiana
3. Reddy, P. P., 2010. Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur
4. Ranjit, P., 2012. Entomological Techniques in Horticultural Crops, New India Publishing Agency.
5. Srivastava.A. 2016. Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

18HO2018 INTRODUCTION TO MAJOR FIELD CROPS

Credits 1:0:1

Course Objectives

- To learn about classification and distribution of field crops
- To learn about the various cropping systems and cultivation practices of major field crops
- To be familiar with fertilizer and herbicide application methods

Course Outcome

At the end of this course, the students will be able to

- Remember classification and distribution of major field crops
- Define and explain the concepts of multiple cropping, mixed cropping, intercropping, relay and alley cropping
- Gain knowledge about major field crops and cropping systems

Theory

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals (rice), pulses (red gram), oil seeds (groundnut), sugar crops (sugarcane) and fodder crops, green manuring, crop rotation.

Practical

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

References:

1. Gurarajan. B., R.Balasubramanian and V.Swaminathan. 2008. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
2. Rajendra Prasad 2002. Text Book of Field crops Production,ICAR, New Delhi.
3. Reddy. S.R. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
4. Singh. S.S. 2005. Crop Management. Kalyani Publishers, New Delhi. UAS, Bangalore. 2011.
5. Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi. 2018.
6. Peter K.V. 2018. Zero hunger in India: Policies and Perspectives. Brillion Publishing.

18HO2019 ECONOMICS AND MARKETING

Credits: 2:0:1

Course Objectives

- To understand the concept of agricultural market structure and its classification
- To study the theories of demand and supply of agricultural produce in market-oriented economy
- To be familiar with marketing of agricultural produce and to prepare projects individually

Course Outcome

At the end of this course, the students will be able to

- Recall the concepts of agricultural marketing
- Understand about marketing margin and marketing functions
- Plan for proposing individual project in cost effective manner

Theory

Terms and definitions in Economics; Consumption, demand and supply. Factors affecting production. Gross Domestic Product (GDP) – Role of **poultry** sector in National GDP. Marketing- Definition, marketing process, need for marketing, role of marketing, marketing functions, classification of markets, marketing of various channels, price spread, marketing efficiency, integration, constraints in marketing of agricultural produce, market intelligence, bank norms, insurance, SWOT analysis, crisis management. Techno-economic parameters for preparation of projects and basic guidelines for preparation of project report.

Practical

Techno-economic parameters for preparation of project. Preparation of bankable projects for various agricultural products and its value-added products. Identification of marketing channel, calculation of price spread, identification of market structure and visit to different markets.

References

1. Philip, K. 2004. Marketing Management. Prentice Hall, New Delhi.
2. Philip, K. 2004. Principles of Marketing. Prentice Hall, New Delhi.
3. Dewett, K.K. 2005. Modern Economic Theory. S. Chand, New Delhi.
4. Dewett, K.K., Verma. 2004 Elementary Economic Theory, S.Chand, New Delhi
5. Jhingam, M.L. 2001. Micro Economic Theory. Konark publishers, New Delhi
6. Subba Reddy. S. Raghu Ram. P. Neela Kanta Sastry. T.V. Bhavani Devi. I. Agricultural Economics (2nd Edn.). 2008
7. Acharya. S.S. Agricultural Marketing in India (7th Edn.). 2019.

18HO2020 HORTI-BUSINESS MANAGEMENT

Credits: 2:0:0

Course Objectives

- To learn about farm and business management principles
- To study the concepts of economics, materials and operations management, inventory control and marketing management
- To learn about financial management, budgeting, and project management

Course Outcome

At the end of this course, the students will be able to

- Recall farm and business management concepts
- Understand forms of business management, operations and materials management, financial management, personnel management, and inventory control,
- Gain knowledge on planning marketing programmes, preparing financial statements, budgeting and project management

Theory

Farm management - definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concepts, curves and functions – factors, product, relationship – factors relationship, product relationship, optimum conditions, principles of opportunity cost-equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work,

controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation evaluation measures.

Suggested Reading

1. Heady Earl O and Herald R. Jenson, 1954, Farm Management Economics. Prentice Hall, New Delhi
2. S.S. Johl, J.R. Kapur, 2006, Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi
3. Karan Singh and Kahlon A S. Economics of Farm Management in India. Theory and Practice. New Delhi.
4. Allied L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
5. Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
6. P.C. Thomas. Managerial Economics, 9th Ed. Kalyani Publishers.
7. K.K. Dewett and M.H. Navalur. Modern Economic Theory. S. Chand & Sons, New Delhi.
8. P. Subba Rao. Human Resource Management. Himalaya Publications.
9. S.P. Jain. Financial Accounting. Kalyani Publications, Ludhiana.
10. Shapiro E. Macroeconomic analysis. Galgotia Publications Delhi
11. Barry P J, Hopkins J A and Baker C B. Financial Management in Agriculture, 6th ed. Danville, IL Interstate Publishers.
12. Gittiner, J P., 1982. Economic analysis of agricultural projects. The John Hopkins University Press Baltimore, USA,
13. Benjamin Mc Donald P 1985. Investment Projects in Agriculture- Principles and Case studies. Longman Group Limited. Essex. UK y Pandey
14. U K 1990. An Introduction to Agricultural Finance .Kalyani Publishers New Delhi.

18HO2021 POSTHARVEST MANAGEMENT AND PROCESSING OF HORTICULTURAL CROPS

Credits 2:0:2

Course Objectives

- To learn about the importance of postharvest technology of horticultural crops and related concepts
- To be familiar with post-harvest operations of fruits, vegetables, ornamentals, plantation crops, spices, medicinal and aromatic plants
- To be familiar with government schemes and regulations with regard to import and export of horticultural produce
- To learn about the various food processing methods of horticultural crops

Course Outcomes

- Remember the different post harvest management in important horticultural crops
- Explain the value addition process of important horticultural crops
- Develop knowledge about the government schemes and laws in import and **Theory**

Importance of Postharvest Technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants. Pre-harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process. Postharvest treatments of horticultural crops. Quality parameters and specifications. Structure of fruits, vegetables and cut

flowers related to physiological changes after harvest. Pre-harvest treatment and pre-cooling, prestorage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging. Principles and methods of preservation by heat - pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops, spices and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Equipments used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

References:

1. Verma, L. R. and Joshi, V. K. 2000. *Post Harvest Technology of Fruits and Vegetables*. Vol. I & II. Indus Publishing Co., New Delhi.
2. FAO - Training Manual No.17/2. 2007. *Prevention of post harvest food losses: Fruits, Vegetables and Root crops*. Daya Publishing House, Delhi.
3. Morris, T. N. 2006. *Principles of Fruit Preservation*. Biotech Books, Delhi. 81-7622-116-3.
4. Rathore N.S., G.K. Mathur., Chasta S.S. 2012. *Post-Harvest Management and Processing of Fruits and Vegetables*. The Energy And Resources Institute
5. Srivastava, R. P. & Sanjeev Kumar. 2002. *Fruits and vegetable Preservation – Principles and Practice*. International Book Distributing Co., Lucknow.

18HO2022 BREEDING AND SEED PRODUCTION OF FLOWER AND ORNAMENTAL PLANTS

Credits 2:0:1

Course Objectives

- To study about breeding methods and techniques of important flowers and ornamentals
- To learn about the various seed production and biotechnological techniques for genetic improvement of flowers and ornamentals
- To be familiar with seed certification laws

Course Outcome

At the end of this course, the students will be able to

- Remember the different breeding aspects in important flower and ornamental crops
- Explain the seed production techniques in important flower and ornamental crops
- Gain knowledge about seed certification

Theory

History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops viz., Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia Heliconia, Lilium, Gaillardia, Petunia, *Hibiscus*, Bouganvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, crossandra, marigold, geranium, antirrhinum, china aster, orchids, anthurium, carnation, hibiscus etc. Breeding for disease resistance.

Development of promising cultivars of important ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

Practical

Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods.

References:

1. Bose T.K, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers*. Partha Sankar Basu.
2. Bhattacharjee S.K and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur, India.
3. Callaway D.J and M.B. Callaway. 2000. *Breeding Ornamental Plants*. Timber Press
4. Singh A.K. 2014. *Breeding and Biotechnology of Flowers : Vol.02 Garden Flowers*. New India Publishing Agency
5. Vainstein A. 2002. *Breeding for Ornamental: Classical and Molecular Approaches*. Springer Publishers

18HO2023 NEMATODE PESTS OF HORTICULTURAL CROPS AND THEIR MANAGEMENT

Credits 1:0:1

Course Objectives

- To study taxonomy, classification, and characteristics of plant parasitic nematodes
- To learn about the role of nematodes in plant disease complex
- To be familiar with principles of integrated nematode management

Course Outcome

At the end of this course, the students will be able to

- Remember taxonomy, classification and characteristics of plant-parasitic nematodes
- Explain role of nematodes in plant disease complex
- Gain knowledge on Integrated nematode management

Theory

History and development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, subtropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex. Integrated nematode management.

Practical

Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

References:

1. Aurelio Ciancio and K.G. Mukerji. 2009. *Integrated Management of Fruit Crops Nematodes*. Springer Publications.
2. Jonathan E.I, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, *Agricultural Nematology*. TNAU, Coimbatore.
3. Vasanth Raju David, B. 2001. *Elements of economic entomology*. Popular book Depot, Chennai.

18HO2024 APICULTURE, SERICULTURE AND LAC CULTURE

Credits 1:0:1

Course Objectives

- To learn about different beneficial insects such as honey bee, silkworm and lac insect
- To study in detail about the classification, life cycle and maintenance of honey bee
- To learn about rearing of mulberry silkworm, mulberry cultivation, and economics of silk production and lac growing in India
- To know about the pest and diseases of honey bees, silkworms and lac insects

Course Outcome

At the end of this course, the students will be able to

- Remember various kinds of beneficial insects
- Explain rearing techniques/methods used for mass production of beneficial insects
- Gain knowledge about the pest and disease of honey bees, silkworms and lac insects and other constraints in mass production of beneficial insects

Theory

Introduction to beneficial insects. Importance and History of apiculture. Species of honey bees, Rock bee, Little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons, Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues. Importance, History and development in India, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs. Silkworm rearing young age /chawki rearing and old age rearing of silkworms. Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture- Mulberry varieties, package of practices, Pests and diseases and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.

Practical

Honey bee colony, different bee hives and apiculture equipment. Summer and Winter management of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipments for silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

References:

1. David B.R and V.V.Ramamurthy. 2007 Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai
2. Mishra R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
3. Narasaiah M.L. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.
4. Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).
5. Sunita, N.D, Guled ,M.B, Mulla S.R and Jagginavar,2003, Beekeeping, UAS Dharwad
6. Srivastava K.P .A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

18HO2025 STUDY TOUR – II

Credits 0:0:1

Course Objectives

- To be familiar with the various horticultural research stations in the state of Tamilnadu/India
- To learn about the ongoing agricultural research and extension programmes organized by various horticultural research stations in the state/Country

Course Outcome

At the end of this course, the students will be able to

- Gain practical knowledge about horticultural crops and cropping systems in the different agro-climatic zones and horticultural crops in Tamil Nadu
- Learn social, cultural aspects of different agricultural zones in TamilNadu
- Identify and analyze different soil types and cropping systems for horticultural crops in Tamil Nadu

Course Content:

The study tour programme is of one week, during this period various Agricultural Research Stations, Institutions or Colleges will be visited. This is to get an exposure of various ongoing research and extension activities in different agro- eco systems in the State/Country.

Evaluation and mark distribution

In the study tour programme, full attendance is mandatory for a pass as per the ICAR regulations.

The marks awarded as follows for the evaluation of the courses

Attendance and general behaviour	- 35
Report of the study tour	- 35
Exam (internal)	- 20
Viva	- 10
Total	- 100

LIST OF COURSES

S.No.	Course Code	Name of the Course	Credits
1	18HO1001	Fundamentals of Horticulture	2:0:1
2	18HO1002	Growth and Development of Horticultural Crops	2:0:1
3	18HO1003	Propagation and Nursery Management for Horticultural Crops	2:0:1
4	18HO1004	Production Technology of Tropical and Subtropical Fruits	2:0:1
5	18HO1005	Production Technology of Tropical and Subtropical Vegetables	2:0:1
6	18HO1006	Irrigation and Weed Management in Horticultural Crops	2:0:1
7	18HO2001	Commercial Floriculture	2:0:1
8	18HO2002	Production Technology of Spices and Plantation Crops	2:0:1
9	18HO2003	Precision Farming and Protected Cultivation	2:0:1
10	18HO2004	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	2:0:1
11	18HO2005	Soil Fertility and Nutrient Management	1:0:1
12	18HO2006	Production Technology of Temperate Vegetable Crops	1:0:1
13	18HO2007	Production Technology of Temperate Fruit Crops	1:0:1
14	18HO2008	Production Technology of Medicinal and Aromatic Crops	2:0:1
15	18HO2009	Breeding of Vegetables, Medicinal and Aromatic Crops	3:0:1
16	18HO2010	Diseases of Vegetables, Flowers, Ornamentals and Spice Crops	2:0:1
17	18HO2011	Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops	2:0:1

18HO1001 FUNDAMENTALS OF HORTICULTURE

Credits 2:0:1

Course Objectives

- To study the basics of horticulture and horticultural practices
- To expose the students to different horticulture divisions
- To impart knowledge on different types of plant propagation and propagating structures

Course Outcome

- Basics of horticulture and classification of crops learned
- Different types of plant propagation techniques and propagating structures studied
- Gain practical knowledge in Special horticultural practices

Theory

Scope and importance, nutritive value - Classification of horticultural crops, Area, production, exports and imports, Agro-climatic zones of India - Nursery techniques and their management, Vegetable gardens, nutrition, kitchen garden and other types of gardens, Phases of growth and development - Factors affecting growth and development –Propagation of horticultural crops –Cutting and Layering - Grafting and Budding - Rootstock - scion relationships, Compatibility and incompatibility - Asexual propagation – Apomixis and Polyembryony - Orchard establishment - Principles, planning and layout of orchards - Planting systems and planting densities –Management of orchards – Intercultural operations, Principles objectives and types of pruning - training - Fruit set - carbon nitrogen relation, structure and process in relation to set and drop, factors affecting and measures to overcome drop - Bearing habit and Classification of bearing habits of fruit trees - Problems of unfruitfulness - internal factors, external factors – measures to overcome - Seedlessness in horticultural crops - significance and induction - Plant growth regulators - Water management– irrigation methods, merits and demerits - Weed management – Fertility management in horticultural crops-manures and fertilizers - Cropping systems, intercropping, multi-tier cropping - Rejuvenation of old orchards, top working and frame working - Production and practices for fruit, vegetable and floriculture crops - Principles of organic farming - Supply chain management.

Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage, Visit to Private and Govt. nursery and orchard.

Text books

1. Jitendra Singh, 2004. Basic of horticulture. Kalyani publishers, Ludhiana.
2. Kumar, N.1997. Introduction to Horticulture, Rajalakshmi Publication, Nagercoil, TamilNadu.

18HO1002 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS

Credits 2:0:1

Course objectives

- To impart knowledge on basis of growth and development of horticultural crops
- To study the effects of factors responsible for physiological processes
- To learn physiological basis of horticultural practices

Course outcomes

- Gained knowledge on basis of growth and development of horticultural crops
- Students learnt the effects of factors responsible for physiological processes in horticultural crops
- Gained knowledge on physiological basis of horticultural practices

Theory

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

Text books

1. Zeiger. 2003.Plant Physiology. Panima. New Delhi.
2. Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.
3. Edward E. Durna. 2014. Principles of Horticultural Physiology. CABI, UK.

18HO1003 PROPAGATION AND NURSERY MANAGEMENT FOR HORTICULTURAL CROPS

Credits 2:0:1

Course Objectives

- To impart skill oriented knowledge on media preparation and handling of tools for propagation
- To teach students on propagation methods
- To familiarize with the maintenance and after care of propagated plants

Course Outcome

- Students benefited with hands-on training in media preparation handling of tools for propagation
- Students learnt about mother plant selection and propagation techniques
- Students familiarized with the maintenance and after care of propagated plants

Theory

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification & stratification) internal and external factors, nursery techniques nursery management, apomixes – monoembryony, Polyembryony, chimera & bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), use of growth regulators in seed, types and stages of seed germination with examples and vegetative propagation, methods and techniques of division-stolons, pseudo-bulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micro-propagation – Micro-grafting, meristem culture, callus culture, anther culture, organogenesis, Somaclonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery.

Practical

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, grafting and budding including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery. Cost of establishment of propagation structures.

Text books

1. Hartmann, H.T., D.E. Kester, F.T. Davies and R.L. Greeneve. 2006 Plant Propagation. Principles and Practices. Prentice Hall of India Private Ltd., New Delhi.
2. Prasad, S. and U. Kumar, 2005. Principle of Horticulture. 3rd edition, Agrobios, India.

18HO1004 PRODUCTION TECHNOLOGY OF TROPICAL AND SUBTROPICAL FRUITS

Credits 2:0:1

Course Objective:

- To impart knowledge on basic cultural practices of Tropical and Subtropical Fruitscrops
- To insist on modern techniques to increase the yield and production
- To learn about the special practices, harvesting and post-harvest handling of Tropical and Subtropical Fruits

Course Outcome:

- The student gains a thorough knowledge on basic production technology
- Familiarize on modern production techniques
- Acquaintance on special practices, harvesting and post-harvest handling

Theory

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Practical

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

Text books

1. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.
2. H.P.Singh and M.M.Mustafa, 2009. Banana-new innovations. Westville PublishingHouse, New Delhi.
3. M.S.Ladaniya, 2013. Citrus Fruits. Elsevier, India post ltd.
4. Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. Tropical and Sub-Tropical-Vol-I. Nayayudyog-Kolkata
5. Rajput, CBS and Srihari babu, R., 1985. Citriculture. Kalyani Publishers, New Delhi.
6. Chundawat, B.S., 1990. Arid fruit culture. Oxford and IBH, New Delhi.
7. Chadha,K.L. (ICAR) 2002, 2001. Hand book of Horticulture. ICAR, New Delhi.
8. Symmonds, 1996. Banana. II Edn. Longman, London.
9. Radha T and Mathew L., 2007. Fruit crops. New India Publishing Agency.
10. W S Dhillon, 2013. Fruit Productionin India. Narendra Publishing House, New Delhi
11. T.K.Chattopadhyay, 1997. Text book on pomology. Kalyani Publishers, New Delhi.

18HO1005 PRODUCTION TECHNOLOGY OF TROPICAL AND SUBTROPICAL VEGETABLES**Credits 2:0:1****Course Objective:**

- To impart knowledge on basic cultural practices of vegetables crops.
- To insist on modern techniques to increase the yield and production.

- To learn about the economic estimation of commercial vegetable crops.

Course Outcome:

- The student gains a thorough knowledge on basic production technology.
- Familiarize on basic gardening techniques.
- Acquaintance on commercial oriented cultural practices.

Theory

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield, post-harvest handling, economics and marketing of tropical and subtropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

Text book

1. S. Thamburaj, 2014. Text book of vegetable, tuber crops and Spices. ICAR, New Delhi
2. B.R.Choudhary, 2009. A Text book on production technology of vegetables. Kalyani Publishers. Ludhiana.
3. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.
4. T.K.Bose, 2002. Vegetable Crops. Nayaprakash. Kolkata
5. P.Hazra, 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi.
6. T.R.Gopal Krishnan, 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
7. K.V.Kamath, 2007. Vegetable Crop Production. Oxford Book Company. Jaipur
8. M.S.Dhaliwal, 2008. Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana

18HO1006 IRRIGATION AND WEED MANAGEMENT IN HORTICULTURAL CROPS

Credits 2:0:1

Course objectives

- To study soil, water and plant relationships and soil moisture constant with special reference to horticultural plants
- To introduce the concepts of water requirement of horticultural crops and its irrigation management
- To study the importance of weeds its classification and management with reference to horticultural plants

Course objectives

- Students gained practical knowledge on surface irrigation, pressurized irrigation, micro irrigation and fertigation
- Students learnt the layout of micro irrigation (Drip irrigation) to the horticultural crops

- Students gained knowledge on the principles of integrated weed management with special reference to horticultural plants

Theory

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different, methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices. Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Text books

1. Rao, Y.P. and Bhaskar, S.R. 2008. Irrigation Technology. Theory and practice. Agrotech publishing Academy, Udaipur.
2. Dilip Kumar Mujmdar. 2004. Irrigation Water Management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
3. S.V. Patil & Rajakumar, G. R., 2016. Water Management in Agriculture and Horticultural Crops. Satish serial publishing House, Delhi.

18HO2001 COMMERCIAL FLORICULTURE

Credits 2:0:1

Course objectives

- To educate students on commercial flower crops and their market thrust.
- To know about production technology of loose and cut flowers.
- To know about harvesting and post-harvest handling of loose and cut flowers.
- To know about concrete and other floral extraction methods.

Course outcomes

- Understand the production technology of commercial flowers
- Understanding the harvesting and post-harvest handling of loose and cut flowers
- Equipped for entrepreneurship in commercial floriculture

Theory

Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, crossandra, anthurium, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export market, production techniques of flowers and foliage filler materials growing of flowers under protected environments such as glass house, plastic house etc., postharvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers, production techniques for bulbous.

Practical

Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

Reference books

1. Bose, T.K., Yadav, L.P., Pal. P., Parthasarathy, V.A., Das. P., 2003. Commercial flowers. Vol.I and II.Nayaudyog, Kolkata-6.
2. Prasad, S. and U. Kumar, 1998. Commercial floriculture. Agro Botanica. Bikaner - 334 003.
3. Vishnu Swarup. 1997. Ornamental Horticulture. Macmillan India Ltd., NewDelhi-2.
4. Foja Singh, 1997. Advances in Floriculture. Media Today Pvt Ltd., New Delhi-17
5. Roy.A.Larson.1992. Introduction of Floriculture. International Book Distributing Co., Lucknow.
6. Bose,T. K. and P. Yadav. 1989. Commercial flowers. NayaPrakash, Calcutta
7. Bose, T.K., Yadav, L.P., Pal. P., Parthasarathy, V.A., Das. P., 2003. Commercialflowers. Vol.I and II.Nayaudyog, Kolkata-6.
8. Bhattacharjee and De. L.C. 2004 – Advanced Commercial Floriculture. Vol. I & II.
9. Bhattacharjee, S.K., 2004 – Advanced commercial floriculture. Vol. I and II.

18HO2002 PRODUCTION TECHNOLOGY OF SPICES AND PLANTATION CROPS

Credits 2:0:1

Course Objectives

- To teach scope and importance of spices and plantation crops
- To impart knowledge on production technology of spices and plantation crops
- To impart knowledge on special horticultural practices, various processes and their uses

Course Outcome

- Scope and importance of spices and plantation crops learned
- Production technology of spices and plantation plants studied
- Gain practical knowledge on various processes and their commercial uses

Theory

Spices: History, scope and importance, Present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micro-propagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper. Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, pepper, betel

vine ginger, turmeric, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

Plantation crops: History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

Practical

Spices: Identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins.

Plantation crops: Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea. Visit to commercial plantations.

Text books

1. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil
2. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.
3. Shanmugavelu, K.G., N. Kumar and K.V. Peter 2005. Production Technology of Spices and Plantation Crops. Agrobios (India), Jodhpur.
4. Nybe, E.V., N. Miniraj and K.V. Peter. 2007. Spices – Horticulture Science Series Vol. 5. New India Publishing Agency, New Delhi.

18HO2003 PRECISION FARMING AND PROTECTED CULTIVATION

Credits 2:0:1

Course objectives

- To impart knowledge on the protected cultivation of vegetables, fruits and flower crops
- To sensitize the students on hi-tech production technology of fruits, vegetables and flower crops
- To learn about precision production technology for important horticultural crops

Course outcomes

- Gain knowledge on the protected cultivation of vegetables, fruits and flower crops
- Gain practical knowledge on hi-tech production technology of fruits, vegetables and flower crops
- Learn about precision production technology for important horticultural crops

Theory

Precision farming – laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, mapping of soils and plant attributes, site specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of

construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

Practical

Study of different types of greenhouses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization; Visit to commercial greenhouses; Economics of protected cultivation.

Reference books

1. Handbook of agricultural engineering, 2016. ICAR, New Delhi.
2. Adams, C.R. K.M. Bandford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Darya ganj, New Delhi.

18HO2004 DISEASES OF FRUIT, PLANTATION, MEDICINAL AND AROMATIC CROPS

Credits 2:0:1

Course objectives

- To study about Etiology, symptoms, mode of spread and survival of diseases
- To study the symptoms of major diseases and host parasite relationship
- To impart knowledge on integrated management of important diseases of fruit, Plantation, Medicinal and Aromatic Crops

Course outcomes

- Learnt about Etiology, symptoms, mode of spread and survival of diseases
- Gain knowledge of symptoms of major diseases and host parasite relationship
- Learnt about integrated management of important diseases of fruit, Plantation, Medicinal and Aromatic Crops

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, Solanum khasianum and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

Reference books

1. Arjunan.G. Karthikeyan, G, Dinakaran ,D. Raguchander,T. 1999 Diseases of Horticultural Crops, AE Publications, Coimbatore
2. Rangaswamy C.2005, Diseases of crop plants in India –. Prentice Hall of India, Pvt. Limited, New Delhi

18HO2005 SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits 1:0:1

Course Objectives:

1. To study the role of nutrients in horticultural crop production
2. To learn the soil fertility evaluation and soil testing methods
3. To familiarize the concept and management of INM

Course Outcome:

1. Studied the role of nutrients in horticultural crop production
2. Learnt the soil fertility evaluation and soil testing methods
3. Familiarized the concept and management of INM

Theory

Introduction to soil fertility and productivity- factors affecting. Essential plant nutrient elements- functions, deficiency systems, transformations and availability. Acid, calcareous and salt affected soils – characteristics and management. Soil organic matter, Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition, soil buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Plant nutrient toxicity symptoms and remedies measures. Soil test crop response and targeted yield concept. Biofertilizer. Nutrient use efficiency and management. Secondary and micronutrient fertilizer. Fertilizer control order. Manures and fertilizers classification and manufacturing process. Properties and fate of major and micronutrient in soils. Fertilizer use efficiency and management. Effect of potential toxic elements in soil productivity.

Practical

Analysis of soil for organic matter, available N, P and K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils. Estimation of organic carbon content in soil. Determination of Boron and chlorine content in soil. Determination of Calcium, Magnesium and Sulphur in soil. Sampling of organic manure and fertilizer for chemical analysis. Physical properties of organic manure and fertilizers. Total nitrogen in urea and farmyard manure. Estimation of ammonical nitrogen and nitrate nitrogen in ammonical fertilizer. Estimation of water soluble P_2O_5 , Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate. Visiting of fertilizer testing laboratory.

Text books

1. Mengel, et al., 2001. Principles of Plant Nutrition (5th Edition), Springer.
2. Das, D .K., 2011. Introductory Soil Science (3rd Edition), Kalyani Publisher, Ludhiana (India).
3. Yawalkar K S, Agarwal JP and Bokde S, 1992. Manures and Fertilizers. Agri. Horticultural Publishing House, Nagpur.
4. Havlin et al. 2014. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (8th Edition), PHI Learning Pvt. Ltd., Delhi.

18HO2006 PRODUCTION TECHNOLOGY OF TEMPERATE VEGETABLE CROPS

Credits 1:0:1

Course objectives

- To familiarize the students about the scenario of temperate vegetable crops cultivation
- To know about advanced production technologies of temperate vegetable crops
- To learn about post-harvest handling of temperate vegetable crops

Course outcomes

- Scope and importance of temperate vegetable crops learned
- Advance production technology of temperate vegetable crops studied

- Gain practical knowledge on post-harvest handling of temperate vegetable crops

Theory

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing of cabbage, cauliflower, knolkhol, sprouting broccoli, Brussels' sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, Vegetable kale.

Practical

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

Text books

1. Prem Singh Arya and S. Prakash 2002. "Vegetable growing in India", Kalyani publishers, New Delhi
2. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.
3. Bose, T. K, Kabir, J., Maity T. K., Parthasarathy V. A., and Som M. G., 2002. Vegetable Crops Vol. II & III NayaProkash, Kolkata.

18HO2007 PRODUCTION TECHNOLOGY OF TEMPERATE FRUIT CROPS

Credits1:0:1

Course Objectives

- To know the scenario and scope of temperate fruit crops
- To impart knowledge about the cultivation aspects of temperate fruit crops
- To study the different horticultural practices in cultivation of temperate fruit crops

Course Outcome

- Scope and Importance of temperate fruit crops learnt
- Practical knowledge on the cultivation aspects of temperate fruit crops
- Studied different horticultural practices in cultivation of temperate fruit crops

Theory

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

Text books

1. Bose, T. K. S. K. Mitra, and D. S. Rathore. 1998. Temperate Fruits - Nayaprakash, Calcutta
2. Chattopadhyay, T.K., 2001. A Text Book on Pomology (4 volumes), Kalyani Publishers, Ludhiana.
3. Alice Kurian and K.V. Peter. 2007. Commercial Crops Technology, Horticultural Sciences Series Vol-8. ed. by K.V. Peter, New India Publishing Agency, New Delhi.

18HO2008 PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS

Credits 2:0:1

Course Objectives

- To learn scope and importance of medicinal and aromatic crops
- To study about production technology of medicinal and aromatic plants
- To impart knowledge on various processes, essential oil and their commercial uses

Course Outcome

- Scope and importance of medicinal and aromatic crops learned
- Production technology of medicinal and aromatic plants studied
- Gain practical knowledge various processes, essential oil and their uses of medicinal and aromatic plants

Theory

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils. Medicinal Plants: Withania, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy Ammimajus, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum and other species relevant to the local conditions. Marketing.

Practical

Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Text books

1. Alice Kurian, M. Asha Sankar (Authors) & K.V. Peter (Ed.), 2007. Medicinal Plants, (Horticulture Science Series-2)Published by New India Publishing Agency, New Delhi.
2. Kumar, N, Md. Abdul Khader, P. Rangasamy, and I. Irulappan, 1994. Spices, Plantation Crops, Medicinal and Aromatic plants, Rajalakshmi Publications, Nagercoil.
3. Chadha, K. L. (ed.) 2001. Handbook of Horticulture. ICAR Publication, New Delhi.

18HO2009 BREEDING OF VEGETABLES, MEDICINAL AND AROMATIC CROPS

Credits 3:0:1

Course objective

- To study the basics of floral biology of Vegetables, Medicinal and Aromatic crops
- To gain knowledge on pollination mechanism, breeding strategies in Vegetables, Medicinal and Aromatic crops
- To learn about methods of breeding and achievements in crop improvement of Vegetables, Medicinal and Aromatic crops

Course outcome

- To learnt basics of floral biology of Vegetables, Medicinal and Aromatic crops
- Practical knowledge gained on pollination mechanism, breeding strategies in Vegetables, Medicinal and Aromatic crops
- Learnt about methods of breeding and achievements in crop improvement of Vegetables, Medicinal and Aromatic crops

Theory

Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops Tomato, Brinjal, Bhendi, Capsicum, Chilli, Cucurbits, Cabbage, Cauliflower, Tuber crops, Potato, Carrot, Radish. Breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adoptability and stability. Floral biology, methods of breeding and achievements in crop improvement medicinal crops :senna, gloriosa and coleus and aromatic crops: mint and cymbopogon.

Practical

Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Text Books

1. Prem Singh Arya, 2003. Vegetable breeding, production and seed production, Kalyani publishers, New Delhi.
2. Harihar Ram. 1998. Vegetable Breeding – Principles and Practices. Kalyanipublishers, New Delhi.
3. Akhilesh Sharma, VivekaKatoch, Susheel Sharma and Chanchal Rana, 2016. Practical on Vegetable breeding. Kalyani Publishers, New Delhi.

18HO2010 DISEASES OF VEGETABLES, FLOWERS, ORNAMENTAL AND SPICE CROPS

Credits 2:0:1**Course Objectives:**

- To impart knowledge on diseases of vegetables, flowers, ornamental and spice crops
- To make the student understand the symptoms and their spread
- To learn basics of plant disease management

Course Outcome:

- Able to know and understand diseases of vegetables, flowers, ornamental and spice crops and losses
- Knowledge on symptoms and their mode of spread will be imparted
- Plant disease management will be studied

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerbera, anthurium, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

Practical

Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops in field as well as in protected cultivation.

Reference books

1. Srikant Kulkarni, Yashoda R. Hedge. Diseases of Plantation crops and their management-, Agrotech publication Academy
2. S.L. Godara, BBS Kapoor, B.S. Rathore. Disease management of spice crops-, Madhu Publications.
3. L.DarwinChristdhar Henry and H.LewinDevasahayam Crop diseases: Identification, Treatment and Management. An Illustrated Handbook –, New India publishing Agency
4. Singh, R.S. 1994. Diseases of Vegetable Crops. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
y Singh, R.S 1996. Plant Diseases. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
5. Sohi, H.S. 1992. Diseases of Ornamental plants in India. ICAR, New Delhi
6. RangaSwamy, G. 1988. Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Saha, L.R. 2002. Hand Book of Plant Diseases. Kalyani Publishers
8. Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. Diseases of Horticultural Crops. .Dept. of Plant Pathology, Tamilnadu Agricultural University Coimbatore.

18HO2011 INSECT PESTS OF FRUIT, PLANTATION, MEDICINAL & AROMATIC CROPS

Credits 2:0:1

Course objective

- To learn about Insect Ecology and factors responsible for outbreaks
- To study on methods of pest control in Fruit, Plantation, Medicinal & Aromatic crops
- To learn about integrated pest management of Fruit, Plantation, Medicinal & Aromatic crops

Course outcome

- Learnt about Insect Ecology and factors responsible for outbreaks
- Practical knowledge on methods of pest control in Fruit, Plantation, Medicinal & Aromatic crops
- Gain knowledge on integrated pest management of Fruit, Plantation, Medicinal & Aromatic crops

Theory

General – economic classification of insects; Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, belladonna, pyrethrum, costus, crotalaria, datura, *Dioscorea*, mint, opium, *Solanum khasianum* and. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs).

Practical

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.

Text Books

1. David, B.V. 2006. Elements of Economic Entomology. Popular Book Depot, Chennai.
2. Butani, D.K. 2009. Insects and Fruits. Periodical Expert Book Agency, New Delhi.

LIST OF COURSES

Sl. No.	Course Code	Name of the Course	Credits
1	17HO1001	Botany of Horticultural Crops	3:0:0
2	17HO1002	Propagation of Horticultural Crops	2:0:1
3	17HO1003	Production Technology of Tropical Fruit Crops	2:0:1
4	17HO1004	Production Technology of Tropical Vegetable Crops	2:0:1

17HO1001 BOTANY OF HORTICULTURAL CROPS

Credits: 3:0:0

Course Objectives:

- To teach the fundamentals of botany of the horticultural crops
- To expose the student to systematic botany
- To learn the basics of morphology and taxonomy of crops

Course Outcome:

- The students learned the basics of botany
- The students familiarized with botanical terms in relation to horticultural crops
- This fundamental course helped students to understand the breeding of horticultural crops

Description:

Systematic botany– terminology, morphological description and classification – root, stem, leaf, inflorescence, flower and fruit – flowering mechanism – modes of pollination asexual/vegetative reproduction – floral biology – fertilization and fruit set. Principles involved in nomenclature, ICBN rules and recommendations with special reference to names of hybrids and names of cultivated plants. Floral biology, pollination, fruit set and economic part in the families; Anacardiaceae (mango, cashew), Rutaceae (acid lime, sweet orange and mandarin), Musaceae, Moraceae, Vitaceae, Caricaceae, Euphorbiaceae (aonla, cassava, rubber), Myrtaceae (guava, clove), Sapotaceae, Bromeliaceae, Punicaceae, Annonaceae (custard apple), Rhamnaceae and Rosaceae (apple, pear, plum, rose). Floral biology, pollination, fruit set and economic part in the families; Solanaceae (tomato, brinjal, chilli, potato), Malvaceae, Cucurbitaceae (pumpkin, watermelon, muskmelon, ridge gourd, bitter gourd, cucumber), Moringaceae, Fabaceae (peas, French beans), Alliaceae (onion, garlic), Brassicaceae (cabbage, cauliflower, radish), Chenopodiaceae, Amaranthaceae, Convolvulaceae (sweetpotato), Araceae (elephant foot yam, colocasia), Dioscoreaceae (yam, medicinal dioscorea). Floral biology, pollination, fruit set and economic part in the families; Piperaceae (pepper, betelvine) Zingiberaceae (cardamom, turmeric, ginger), Orchidaceae (Vanilla, Dendrobium orchid), Apiaceae (Umbelliferae) (coriander), Myristicaceae, Lauraceae, Leguminosae, Caesalpiniaceae, Camelliaceae, Rubiaceae, Arecaceae(Palmae) (coconut, arecanut, palmyrah, oil palm), Sterculiaceae(Cocoa). Floral biology, pollination, fruit set and economic part in the families; Oleaceae (malligai, mullai, jathimalli), Asteraceae (chrysanthemum, marigold, marikolundu, gerbera, golden rod, aster, pyrethrum), Amaryllidaceae, Acanthaceae, Caryophyllaceae, Iridaceae, Apocynaceae, Poaceae (Graminae), (lemongrass, citrononella, palmarosa, vetiver), Geraniaceae, Lamiaceae (Labiatae) (coleus, patchouli, mint, maruvu), Scrophulariaceae.

Practical:

Observations and recordings of the morphology of root, stem, leaf, flower and fruit. Study of taxonomy and morphology of crops in the above families – herbarium (minimum 50 – covering not less than 25 families) - collection of the crops mentioned in theory.

References:

1. Mauseth, J.D. 2009. Botany: An Introduction to Plant Biology. Jones and Bartlett Publishers, MA.
2. Spichiger, R., Savolainen, V., Figeat, M., Jeanmond, D. 2004. Systematic Botany of Flowering Plants. Science Publishers Inc., USA.
3. Jansi Rani, P. Subramanian, S., Veeraragavathatham and S. Thamburaj, 1997. Botany of Vegetable Crops. KRS Screen Printers, Lawley Road, Coimbatore.
4. Gangulee, Das and Datta. 1997. College Botany Vol. I. New Central Book Agency (P) Ltd., Calcutta
5. Genin, A. 1994. Application of Botany in Horticulture. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Kochhar, S.L. 1992. Economic Botany in the Tropics. Macmillan India Ltd., Madras
7. Madhu Arora, 1991, Dictionary of Botany. Anmol Publications Pvt. Ltd., New Delhi.
8. Joseph Y. Bergen, 1990. Fundamentals of Botany. Arihant Publishers, Jaipur

9. Subhash Chandra Datt, 1989. Systematic Botany – Willey Eastern Ltd., New Delhi.
10. Bahadur and Achari. 1989. A Manual of Botany. Anmol Publications, New Delhi.
11. Sambamurthy and Subrahmanyam. 1989. Text Book of Economic Botany. Wiley Eastern Ltd., New Delhi.
12. Simpson, B.B. and Ogorzaly, M.C. 1986. Economic Botany. McGraw Hill Book Company, New York.

17HO1002 PROPAGATION OF HORTICULTURAL CROPS

Credits: 2:0:1

Course Objectives:

- To impart skill oriented knowledge on media preparation
- To teach students on propagation methods
- To familiarize with the maintenance and after care of propagated plants

Course Outcome:

- Students benefited with hands-on training in media preparation
- Students learned about mother plant selection and propagation techniques
- Students familiarized with the maintenance and after care of propagated plants

Description:

Basics of plant propagation: Scope and importance - different methods - definitions – sexual propagation - importance, advantages and disadvantages - asexual propagation - importance, advantages and disadvantages - agencies involved in the nursery development - government schemes for development of nurseries - establishment of nursery - site selection - tools and implements - mist chamber - phytotron – humidifiers - greenhouse - glasshouse - polyhouse - shade net - cold frames - hot beds - pit nursery - ball and bur lapped culture - media and containers - soil sterilization - manures and manuring - liquid manures. Sexual propagation: Micro and megasporogenesis - apomixis - mono and polyembryony - seeds - quality - nursery bed - protrait culture - sowing - seed viability - longevity - germination - dormancy - types of dormancy - seed treatments - seed invigoration - seedling vigour. Asexual propagation: cutting and layering. Genetic variations - chimeras and types - methods of vegetative propagation identification of plus trees – mother block – raising clonal nursery - types of cuttings – factors influencing rooting of cuttings - use of growth regulators - layering – advantages and disadvantages - methods of layering - anatomical and physiological basis of rooting. Asexual propagation: grafting, budding and propagation through special organs. Grafting and budding; Methods - advantages and disadvantages - rootstocks - scion bank - factors for successful graft union - selection, pre-curing and collection of scion - bud wood selection - bud wood certification - anatomical and physiological basis of graft / bud union - stock-scion relationship - root stock influences - after care and hardening – techniques of propagation through specialized organs - tubers - bulbs - corms - runners - suckers - crown - slips - rhizome - offshoots - top working – quality management and nursery certification –display, packing, transport and marketing. Techniques of micro propagation: Micro propagation – definitions - different methods - protocol of micro propagation - Stage I establishment and sterilization - Stage II shoot multiplication - Stage III root formation - Stage IV acclimatization and hardening – specific protocol for aseptic culture - explants - sterilization techniques - types of media - composition - media preparations - meristem tip culture - micro grafting - in vitro clonal propagation of important horticultural crops - constraints and problems in micro propagation – after care - packing, transport and marketing - infrastructure requirements - establishment of commercial tissue culture units - visit to commercial TC units- status of micro propagation in India.

Practical:

Propagation structures - tools and implements - propagation media - containers - preparation of nursery beds - seed treatment - sowing - plug transplants / seedling production - potting, depotting and repotting of plants - methods of asexual propagation through cuttings, layering, grafting and budding - scion bank – techniques of cuttings - leaf and leaf bud cuttings - stem cuttings - single nodal cuttings and root cuttings - techniques of layering - potting of layers and hardening - grafting methods - separation of grafts - potting and maintenance of grafted plants - budding and maintenance of budded plants - mist chamber - structures - maintenance - use of mist chamber for seed and vegetative propagation - hardening and maintenance – shade structure - nutrition and plant protection - application of growth regulators - standardization of formulations - growth regulators for seed and vegetative propagation - project preparation for commercial nurseries – visit to commercial nurseries and tissue culture units.

References:

1. Adams, C.R., K.M. Bandford and M.P. Early. 1996. Principles of Horticulture. CBS Publishers and Distributors, New Delhi. 110 002.

2. Bose, T.K., S.K. Mitra, M. K. Sadhu and B. Mitra. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prakash, Calcutta
3. Edmond, J.B., T.L. Senna, F.S. Andrews and R.G. Halfacre. 1990. Fundamentals of Horticulture, Tata McGraw Hill Publishing Co. Ltd.
4. Hartmann, H.T., D.E. Kester, F.T. Davies and R.L. Greeneve. 1997. Plant Propagation - Principles and Practices. Prentice Hall of India Private Ltd., New Delhi.
5. Nanda, K.K and V.K. Kochhar. 1995. Vegetative Propagation of Plants. Kalyani Publishers, Ludhiana.
6. Rao, M. K. 1991. Text Book of Horticulture. Macmillan India Ltd., New Delhi 110 002.
7. Rao, M.M. 1990. Recent Developments in Multiplication of Planting Materials by Greenhouse and Tissue Culture Technologies, Short Course Manual of UAS, Dharwad.
8. Sadhu, M.K. 1989. Plant Propagation. Wiley Eastern Ltd., 4835/24, New Delhi 110 002.
9. Singh, S.P. 1983. Mist Propagation. Metropolitan Publishing Company, New Delhi
10. Kumar, U. 2002. Methods in Plant Tissue Culture, Second Edition, Agro Bios, Jodhpur.
11. Parthasarathy, V. A. 2001. Biotechnology of Horticultural Crops Vol. I, II & III, Nayopraakash, Calcutta.
12. Ramswat, K. G. and J.M. Merillan 1999. Biotechnology – Secondary Metabolites Oxford & IBH Publishers, Co (P) Ltd., New Delhi.
13. Purohit, S. S. 1998. Biotechnology: Fundamentals and Applications II Edition; Agro Botanica Bikaner
14. Singh, B.D. 1999. Biotechnology, Kessinger Publishing, New York.
15. Razdon, M.K. 1993. An Introduction to Plant Tissue Culture, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

17HO1003 PRODUCTION TECHNOLOGY OF TROPICAL AND ARID ZONE FRUIT CROPS

Credits: 2:0:1

Course Objectives:

- To impart knowledge on the scenario of fruit cultivation in tropical and arid zones
- To impart knowledge on advanced production techniques
- To apprise on production constraints

Course Outcome:

- Practical knowledge on specialized production techniques of tropical and arid zone fruits
- Understanding the production constraints
- Skill management for solving field problems

Description:

Principles and cultivation of tropical fruits: Mango and banana-Scope and importance of tropical fruits cultivation – overview: global, national and regional levels – area, production and export potential– horticultural zones of India and Tamil Nadu with emphasis on tropical fruits- GAP- organic production - composition and uses – origin and distribution – species and cultivars - climate and soil requirements - species and varieties - cropping systems- propagation techniques - planting systems and planting density - after care – training and pruning – water management, macro and micronutrient management, weed management – special horticultural techniques - use of plant growth regulators - production constraints - physiological disorders – post harvest handling - economics of production. Tropical fruits- Papaya, sapota and guava: Composition and uses – origin and distribution – species and cultivars – climate and soil requirements, cropping systems- varieties - propagation techniques – planting systems and planting density - after care – training and pruning - water management, macro and micronutrient management, weed management – GAP - organic production - special horticultural techniques – sex forms and pollination - use of plant growth regulators - production constraints - physiological disorders - pre and post-harvest handling - economics of production. Tropical fruits: acid lime, sweet orange and jack fruit: Composition and uses – origin and distribution – species and cultivars – climate and soil requirements, cropping systems- varieties - production constraints - propagation techniques - planting systems and planting density - after care – training and pruning - water management, macro and micronutrient management, weed management - GAP - organic production - special horticultural techniques - use of plant growth regulators - physiological disorders - pre and post-harvest handling – economics of production. Arid zone fruits: Aonla, ber, pomegranate and date palm: Dryland horticulture – importance and scope in India and Tamil Nadu- distribution of arid and semi-arid zones in India and Tamil Nadu; Composition and uses – origin and distribution – species and cultivars - climate and soil requirements – varieties - cropping systems and intercropping – crops suitable for dry land system – spacing and planting patterns for rainfed

horticultural crops- in situ grafting and budding techniques – alternative land use systems – mulching – soil and moisture conservation methods – chemical application – anti-transpirants – management of nutrients, water, weeds and problem soils – training and pruning methods – physiology of flowering – regulation of cropping – top working and rejuvenation – use of plant growth regulators – post harvest handling – economics of production. Arid zone fruits - custard apple, jamun, bael, wood apple and manila tamarind: Composition and uses – origin and distribution – species and cultivars – climate and soil requirements – varieties - cropping systems and intercropping – crops suitable for dry land system – spacing and planting patterns for rain fed horticultural crops- in situ grafting and budding techniques – alternative land use systems – mulching – soil and moisture conservation methods – chemical application – anti-transpirants – management of nutrients, water, weeds and problem soils – training and pruning methods – physiology of flowering – crop regulation – top working and rejuvenation – use of plant growth regulators – post harvest handling – economics of production.

Practical:

Description and identification of cultivars/varieties - nursery management - nursery preparation, seed sowing and raising seedlings / rootstocks, practicing propagation techniques of mango, banana, papaya, sapota, guava, acid lime, sweet orange, aonla, ber, pomegranate, date palm, custard apple, jamun, bael, wood apple and manila tamarind. Banana scoring techniques. Selection and pre-treatment of banana suckers - desuckering in banana –planting systems- manures, fertilizers and biofertilizers application in mango, banana, papaya, sapota, guava, acid lime, sweet orange and aonla – application of growth regulators - sex forms in papaya – sibmating and seed production in papaya – latex extraction and preparation of crude papain – training and pruning in mango, sapota, guava, acid lime and sweet orange, aonla, ber, pomegranate and date palm - practising harvesting methods - ripening of fruits - grading and packaging - visit to commercial orchards - project preparation on production economics for fruits.

References:

1. Bose, T. K., S. K. Mitra and D.Sanyal, 2001. Fruits: Tropical and Subtropical. Volume I. Naya Udyog, Calcutta.
2. Chattopadhyay, T. K. 1994. A Text Book of Pomology (Vol 1-3). Kalyani Publishers, New Delhi.
3. Shanmugavelu, K. G. 1987. Production Technology of Fruit Crops. SBA Publications, Calcutta.
4. Singh, S. P. 1995. Commercial Fruits, Kalyan Publishers, Ludhiana.
5. Veeraraghavathatham, D., M. Jawaharlal, S. Jeeva and S. Rabindran, 1996. Scientific Fruit Culture, Suri Associates, Coimbatore.
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17HO1004 PRODUCTION TECHNOLOGY OF TROPICAL VEGETABLE CROPS

Credits: 2:0:1

Course Objectives:

- To teach the students on the scenario of vegetable cultivation
- To impart knowledge on advanced production techniques
- To apprise on production constraints

Course Outcome:

- Hands-on experience of vegetable cultivation
- Knowledge on quality requirement and production techniques
- Skill management for solving field problems

Description:

Overview of vegetable cultivation: Area, production, world scenario, industrial importance, export potential of tropical vegetable crops – institutions involved in vegetable crops research. Classification of vegetable crops - Effect of climate, soil, water and nutrients on vegetable crop production and their management– cropping systems. Vegetable production in nutrition garden, kitchen garden, truck garden, market garden, roof garden, floating garden – types of vegetable farming and contract farming- rice fallow cultivation, river bed cultivation, rain fed cultivation, organic farming – GAP in vegetable production – export standards of vegetables. Solanaceous vegetables and bhendi: Composition and uses – area and production- climate and soil requirements – season-varieties and hybrids – seed rate- nursery practices-containerized transplant production and transplanting –preparation of field-spacing-planting systems-planting- water and weed management-nutrient requirement-fertigation-nutrient deficiencies-physiological disorders- use of chemicals and growth regulators-cropping systems-constraints in production-harvest-

yield crops. Tomato, brinjal, chilli and bhendi. Bulbous and Cucurbitaceous vegetable crops: Composition and uses- area and production- climate and soil requirements – season - varieties and hybrids -seed rate – nursery practices – containerized transplant production and transplanting- preparation of field - spacing - planting systems - planting- water and weed management – nutrient requirement – fertigation - nutrient deficiencies – physiological disorders – sex expression - use of chemicals and growth regulators - cropping systems – constraints in production - harvest – yield. Onion, ash gourd, pumpkin, bitter gourd, snake gourd, ribbed gourd, bottle gourd, watermelon, musk melon, coccinia, cucumber and gherkin. Fabaceous vegetable crops and greens: Composition and uses- origin and distribution- area and production- climate and soil requirements – season - varieties and hybrids - seed rate – preparation of field - spacing - planting systems - planting – water and weed management – nutrient requirement – fertigation - nutrient deficiencies – physiological disorders- use of chemicals and growth regulators - cropping systems – constraints in production harvest – yield. Cluster beans, cowpea, lab-lab, moringa, chekurmanis, palak, basella and amaranth. Tuber crops: Composition and uses- origin and distribution- area and production- climate and soil requirements – season - varieties and hybrids - seed rate –preparation of field - nursery practices and transplanting – spacing - planting systems - planting – water and weed management – nutrient requirement – fertigation - nutrient deficiencies – physiological disorders- use of chemicals and growth regulators - cropping systems – - constraints in production –virus elimination in cassava- harvest – yield. Cassava, sweet potato, colocasia, vegetable coleus, amorphophallus, edible dioscorea, and yam bean.

Practical:

Identification and description of tropical vegetable crops –nursery practices and transplanting for transplanted vegetable crops- preparation of field and sowing /planting for direct sown/ transplanted vegetable crops, kitchen garden- herbicide use in vegetable culture - top dressing of fertilizers and inter-culture – use of growth regulators – identification of nutrient deficiencies - physiological disorders- harvest indices and maturity standards - post harvest handling and storage – marketing – seed extraction- working out cost of cultivation for tropical vegetable crops – project preparation for commercial cultivation. Visit to commercial vegetable growing areas, market and processing centre.

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2. Uma Shankar Singh, 2008. Indian Vegetables, Anmol Publications Pvt., Ltd., New Delhi.
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