DEPARTMENT WISE DISTRIBUTION OF COURSES

1. Agronomy

Course No.	Title of the course	Credit
Agro 1101	Fundamentals of Agronomy	2+1
Agro 1102	Agricultural Heritage (Remedial) (Agronomy & Agrl. Extension)	1+0
Agro 1203	Irrigation and water management	1+1
Agro 2104	Crop Production Technology-I (Cereals, millets, tuber and fodder crops)	1+1
Agro 2205	Crop production Technology– II (Pulses, oilseeds, sugar and fibre crops)	1+1
Agro 3106	Farming system and sustainable agriculture	1+0
Agro 3107	Practical Crop Production – I (Rice and Tuber crops)	0+2
Agro 3208	Practical Crop Production – II (Pulses and oilseeds)	0+1
Agro 3209	Rainfed Agriculture and Watershed Management	1+1
	Total	**8+8=16**

2. Agricultural Meteorology

Course No.	Title of the course	Credit
Agmt 1101	Introductory Agro-meteorology & Climate Change	1+1
	Total	**1+1=2**

3. Soil science and Agricultural Chemistry

Course No.	Title of the course	Credit
Ssac 1101	Fundamentals of Plant Biochemistry	1+1
Ssac 1102	Fundamentals of Soil Science	2+1
Ssac 1203	Manures, Fertilizers and Soil fertility management (SS&AC & Agronomy)	2+1
Ssac 2104	Environmental Studies & Disaster Management (SS&AC & Agrl. Meteorology)	1+1
Ssac 2105	Principles of Organic Farming (SS&AC & Agronomy)	1+1
Ssac 2206	Problem soils and their management	2+0
Ssac 3107	Geoinformatics, Nanotechnology and Precision Farming (SS&AC & Agronomy)	1+1
	Total	**10+6=16**

4. Agricultural Microbiology

Course No.	Title of the course	Credit
Micr 2101	Agricultural Microbiology	2+1
	Total	**2+1=3**

5. Plant Breeding and Genetics

Course No.	Title of the course	Credit
Pbgn 1101	Fundamentals of Genetics	2+1
Pbgn 1202	Fundamentals of Plant Breeding	2+1
Pbgn 2103	Crop improvement I	1+1
Pbgn 2204	Crop improvement II	1+1
Pbgn 3205	Intellectual Property Rights	1+0
	Total	**7+4=11**

6. Seed Science Technology

Course No.	Title of the course	Credit
Sdtec 3201	Principles of Seed Technology	2+1
	Total	**2+1=3**

7. Horticulture

Course No.	Title of the course	Credit
Hort 1101	Fundamentals of Horticulture	1+1
Hort 2102	Production Technology for Plantation crops	2+1
Hort 2203	Production Technology for Spices, Medicinal and aromatic plants	2+1
Hort 2204	Production Technology for Vegetable crops	2+1
Hort 3105	Production Technology for Fruit crops	2+1
Hort 3106	Post-Harvest Management and value addition of horticultural crops	2+1
Hort 3207	Landscaping and ornamental horticulture	1+1
	Total	**12+7=19**

8. Agricultural Entomology

Course No.	Title of the course	Credit
Ento 1201	Fundamentals of Entomology	2+1
Ento 2102	Insect Ecology and Integrated Pest Management	2+1
Ento 2203	Pests of crops and their management I	1+1
Ento 3104	Pests of crops and their management II	1+1
Ento 3205	Management of beneficial insects and non insect pests	1+1
	Total	**7+5=12**

9. Nematology

Course No.	Title of the course	Credit
Nema 3201	Plant parasitic nematodes and their management	1+1
	Total	**1+1=2**

10. Plant Pathology

Course No.	Title of the course	Credit
Path 1101	Fundamentals of Plant Pathology	2+1
Path 2102	Principles of integrated plant disease management	1+1
Path 2203	Diseases of crops and their management I	2+1
Path 3104	Diseases of crops and their management II	2+1
	Total	**7+4=11**

11. Plant Physiology

Course No.	Title of the course	Credit
Crps 1201	Fundamentals of Crop Physiology	2+1=3
	Total	**2+1=3**

12. Agricultural Statistics

Course No.	Title of the course	Credit
Stat 2101	Agri.-Informatics	1+1
Stat 3202	Statistical methods and applications	2+1
	Total	**3+2=5**

13. Agricultural Engineering

Course No.	Title of the course	Credit
Engg 1201	Soil and Water Conservation Engineering	1+1
Engg 2102	Farm Machinery and Power	1+1
Engg 3103	Protected Cultivation and Secondary Agriculture	1+1
Engg 3204	Renewable Energy and Green Technology	1+1
	Total	**4+4=8**

14. Agricultural Economics

Course No.	Title of the course	Credit
Econ 1201	Fundamentals of Agricultural Economics	2+0
Econ 2102	Agricultural Finance and Co- operation	1+1
Econ 3103	Farm Management ,Production and Resource Economics	2+1
Econ 3204	Agricultural Marketing , Trade & Prices	2+1
	Total	**7+3=10**

15. Animal Husbandry

Course No.	Title of the course	Credit
Anhs 1201	Livestock and Poultry Management	1+1
	Total	**1+1=2**

16. Agricultural Extension

Course No.	Title of the course	Credit
Extn 1101	Rural Sociology & Educational Psychology	2+0
Extn 1203	Fundamentals of Extension Education and Rural Development	2+1
Extn 2204	Communication Skills and Personality Development	1+1
Extn 3105	Entrepreneurship Development and Agricultural Extension Management	1+1
	Total	**6+3=9**

17. Home Science

Course No.	Title of the course	Credit
Hmsc 3201	Principles of Food Science & Nutrition	2+0=2
	Total	**2**

18. Plant Biotechnology

Course No.	Title of the course	Credit
Biot 2201	Fundamentals of Plant Biotechnology	2+1
	Total	**2+1=3**

19. Forestry

Course No.	Title of the course	Credit
Fors 2201	Introduction to Forestry	1+0
	Total	**1+0=1**

20. Non-Gradial Courses

Course No.	Title of the course	Credit
Extn 1102	Human Values & Ethics	1+0
Engl 1101	Comprehension & Communication Skills in English	0+1
Nsnc 1101	NSS/NCC	0+1
Peyp 1201	Physical Education & Yoga Practices	0+1
Etur 3201	Educational Tour I (All India)	0+1
Etur 4102	Educational Tour II (All Kerala along with RAWE)	0+1
	Total	**1+5=6**
	RAWE+ ELP (Student READY)	**20 +20=40**
	Grand Total	**144+20+20=184**

SEMESTER – WISE DISTRIBUTION OF COURSES

Semester I

Sl. No.	Cat. No.	Title of the Course	Credit
1	Agro 1101	Fundamentals of Agronomy	2+1
2	Agro 1102	Agricultural Heritage (Remedial) (Agronomy & Agrl. Extension)	1+0
3	Agmt 1101	Introductory Agro-meteorology & Climate Change	1+1
4	Ssac 1101	Fundamentals of Plant Biochemistry	1+1
5	Ssac 1102	Fundamentals of Soil Science	2+1
6	Pbgn 1101	Fundamentals of Genetics	2+1
7	Hort 1101	Fundamentals of Horticulture	1+1
8	Path 1101	Fundamentals of Plant Pathology	2+1
9	Extn 1101	Rural Sociology & Educational Psychology	2+0
10	Extn 1102	Human Values & Ethics (Non Gradial)	1+0
11	Engl 1101	Comprehension & Communication Skills in English (Non Gradial)	0+1
12	Nsnc 1101	NSS/NCC (Non Gradial)	0+1
		Total Credit	**15+9=24**

Semester II

Sl. No.	Cat. No.	Title of the Course	Credit
1	Agro 1203	Irrigation and water management	1+1
2	Ssac 1203	Manures, Fertilizers and Soil fertility management (SS&AC & Agronomy)	2+1
3	Pbgn 1202	Fundamentals of Plant Breeding	2+1
4	Ento 1201	Fundamentals of Entomology	2+1
5	Crps 1201	Fundamentals of Crop Physiology	2+1
6	Engg 1201	Soil and Water Conservation Engineering	1+1
7	Econ 1201	Fundamentals of Agricultural Economics	2+0
8	Anhs 1201	Livestock and Poultry Management	1+1
9	Extn 1203	Fundamentals of Extension Education and Rural Development	2+1
10	Peyp 1201	Physical Education & Yoga Practices (Non Gradial)	0+1
		Total Credit	**15+9=24**

Semester III

Sl. No.	Cat. No.	Title of the Course	Credit
1	Agro 2104	Crop Production Technology-I (Cereals, millets, tuber and fodder crops)	1+1
2	Ssac 2104	Environmental Studies & Disaster Management (SS&AC &Agrl. Meteorology)	1+1
3	Ssac 2105	Principles of Organic Farming (SS&AC & Agronomy)	1+1
4	Micr 2101	Agricultural Microbiology	2+1
5	Pbgn 2103	Crop improvement I	1+1
6	Hort 2102	Production Technology for Plantation crops	2+1
7	Ento 2102	Insect Ecology and Integrated Pest Management	2+1
8	Path 2102	Principles of integrated plant disease management	1+1
9	Stat 2101	Agri- Informatics	1+1
10	Engg 2102	Farm Machinery and Power	1+1
11	Econ 2102	Agricultural Finance and Co- operation	1+1
		Total Credit	**14+11=25**

Semester IV

Sl. No.	Cat. No.	Title of the Course	Credit
1	Agro 2205	Crop production Technology– II (Pulses, oilseeds, sugar and fibre crops)	1+1
2	Ssac 2206	Problem soils and their management	2+0
3	Pbgn 2204	Crop improvement II	1+1
4	Hort 2203	Production Technology for Spices, Medicinal and aromatic plants	2+1
5	Hort 2204	Production Technology for Vegetable crops	2+1
6	Ento 2203	Pests of crops and their management I	1+1
7	Path2203	Diseases of crops and their management I	2+1
8	Extn 2204	Communication Skills and Personality Development	1+1
9	Biot 2201	Fundamentals of Plant Biotechnology	2+1
10	Fors 2201	Introduction to Forestry	1+0
Total credit			**15+8=23**

Semester V

Sl. No.	Cat. No.	Title of the Course	Credit
1	Agro 3106	Farming system and sustainable agriculture	1+0
2	Agro 3107	Practical Crop Production – I (Rice and Tuber crops)	0+2
3	Ssac 3107	Geoinformatics, Nanotechnology and Precision Farming (SS&AC & Agronomy)	1+1
4	Hort 3105	Production Technology for Fruit crops	2+1
5	Hort 3106	Post-Harvest Management and value addition of horticultural crops	2+1
6	Ento 3104	Pests of crops and their management II	1+1
7	Path 3104	Diseases of crops and their management II	2+1
8	Engg 3103	Protected Cultivation and Secondary Agriculture	1+1
9	Econ 3103	Farm Management ,Production and Resource Economics	2+1
10	Extn 3105	Entrepreneurship Development and Agricultural Extension Management	1+1
		Total Credit	**13+10=23**

Semester VI

Sl. No.	Cat. No.	Title of the Course	Credit
1	Agro 3208	Practical Crop Production – II (Pulses and oilseeds)	0+1
2	Agro 3209	Rainfed Agriculture and Watershed Management	1+1
3	Pbgn 3205	Intellectual Property Rights	1+0
4	Sdtec 3201	Principles of Seed Technology	2+1
5	Hort 3207	Landscaping and ornamental horticulture	1+1
6	Ento 3205	Management of beneficial insects and non insect pests	1+1
7	Nema 3201	Plant parasitic nematodes and their management	1+1
8	Stat 3202	Statistical methods and applications	2+1
9	Engg 3204	Renewable Energy and Green Technology	1+1
10	Econ 3204	Agricultural Marketing , Trade & Prices	2+1
11	Hmsc 3201	Principles of Food Science & Nutrition	2+0
12	Etur 3201	Educational Tour I (All India) (Non Gradial)	0+1
Total Credit			**14+10=24**

Semester VII

Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE &AIA) (STUDENT READY)		
Activities	**No. of weeks**	**Credit Hours**
General orientation & On campus training by different faculties	1	14
Village attachment	8	
Unit attachment in Univ./ College. KVK/ Research Station Attachment	5	
Plant clinic	2	02
Agro-Industrial Attachment	3	03
Project Report Preparation, Presentation and Evaluation	1	01
Total weeks for RAWE & AIA	0+20	0+20
Etur 4102 – Educational Tour II (All Kerala) (Non Gradial)	0+1	0+1
Total	**0+21**	**0+21**

Semester VIII

Experiential Learning Programme (ELP)

This program is to be undertaken by the students preferably during the eighth semester for a total duration of 24 weeks with a weightage of **0+20** Credit Hours. The students will register for any of two modules, listed below, of **0+10** credit hours each.

Experiential Learning courses

Sl. No	**Course No**	**Title of the course**	**Credit**	**Department.**
1.	Elcp 4201	Seed Production Technology	0+10	Seed Science and Technology and Plant Breeding and Genetics
2.	Elcp 4202	Soil, plant, water and seed testing services	0+10	Agronomy, SS&AC, Seed Science and Technology
3.	Elcp 4203	Hybrid Seed Production Technology	0+10	Plant Breeding and Genetics, Seed Science and Technology and Olericulture
4.	Elcp 4204	Agriculture Waste Management	0+10	SS&AC, Agrl. Microbiology, Agronomy
5.	Elcp 4205	Organic Production Technology	0+10	Agronomy, SS&AC
6.	Elcp 4206	Quality Assurance of Manures, Fertilizers and Agrochemicals	0+10	SS&AC
7.	Elcp 4207	Commercial Production of Seeds of Pulses and Forage Legumes	0+10	Agronomy
8.	Elcp 4208	Seed and Seedling Production of Vegetables	0+10	Olericulture
9.	Elht 4201	Floriculture and Landscaping	0+10	Pomology and Floriculture
10.	Elht 4202	Food Processing and Food safety standards	0+10	Processing Technology, Food Science and Nutrition
11.	Elht 4203	Commercial Vegetable Production	0+10	Olericulture

12.	Elht 4204	Nursery Management	0+10	Pomology, Plantation Crops
13.	Elpt 4201	Bioagents and Biofertilizer production	0+10	Agrl. Entomology, Agrl. Microbiology/Plant Pathology, Nematology
14.	Elpt 4202	Mushroom Cultivation	0+10	Plant Pathology
15.	Elpt 4203	Beekeeping	0+10	Agrl. Entomology
16.	Elpt 4204	Detection and Management of plant pathogens	0+10	Plant Pathology
17.	Elab 4201	Agri-business management	0+10	Agrl. Economics
18.	Elss 4201	Agro-Advisory Services	0+10	Agrl. Extension
19.	Elss 4202	Agricultural Information Support Services	0+10	Agrl. Extension
20.	Elbt 4201	Tissue culture technologies	0+10	Plant Biotechnology
21.	Elbt 4202	Molecular Diagnostics	0+10	Plant Biotechnology

Evaluation of Experiential Learning Programme

Sl.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**

AGRONOMY

1. Agro 1101 Fundamentals of Agronomy (2+1)

Theory

Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops. 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.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, Effect of sowing depth on germination and seedling vigour, 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 populationand, herbicides, Use of tillage implements-reversible plough, one way plough, harrow, leveler, seed drill

Lecture schedule

1. Meaning, definition and scope of agronomy- divisions of agronomy- Relationship with other disciplines
2. Classification of crops based on the intensity of cultivation, uses, ontogeny/ life span, growth habit, and climatic response and/or habitat- Agronomic classification of crops
3. Botanical classification- Category of cultivars- classification based on special purpose
4. Growth, definition - factors affecting growth - Crop yield contributing characters biological and economic yield- harvest index
5. Crop density - plant population and yield –optimum plant population- planting geometry and its effect on growth and yield.
6. Seed – definition - characteristics of good quality seed
7. Methods of sowing/planting- direct seeding: broadcasting, dibbling and drilling, transplanting-
8. Tillage- definition- objectives – types of tillage- conservation tillage

9 -10. Tillage implements-ploughs, harrows, cultivators, hoes and special purpose implements

11. Tilth - characteristics of good tilth

12-13. Crop nutrition - Soil productivity and fertility-– classification of nutrients – functions and deficiency symptoms of major and secondary nutrients

14. Manures and fertilizers – classification - organic manures
15. Fertilizers and fertilizer use- Management of fertilizers - Integrated Nutrient Management
16. Biological nitrogen fixation - biofertilizers-
17. Plant ideotypes – concept, definition, ideotypes of rice for different growing conditions
18. Crop rotation – principles - definition – importance of break crops – advantages – practices

Mid Term Examination

19-20. Weeds-introduction, definition- characteristics of weeds- harmful and beneficial effects- uses

21-22. Classification of weeds — propagation and dissemination

23-25. Crop weed association- crop weed competition- critical period of weed competition-

26. Concepts of weed prevention, eradication, and control.

27-28. Weed control methods – physical, cultural, biological, chemical, allelopathy

29-30. Introduction to herbicides: advantages and limitation of herbicides- Herbicide usage in India- classification

31. Herbicide formulations- methods of application- adjuvants and their use in herbicides

32-33. Introduction to selectivity of herbicides – fate of herbicides in the plant and soil;
34. Herbicide resistance – history, importance and implications
35-36. Integrated weed management in rice

Practical schedule

1. Visit to crop museum and identification of crops and seeds
2. Study of tillage implements
3. Different methods of sowing and effect of sowing depth on germination and seedling vigour
4. Identification of manures and fertilizers
5. Fertilizer recommendation and calculations
6. Methods of fertilizer applications- broadcasting, placement, foliar application and fertigation
7. Computation of seed rate, plant population
8. Yield contributing characters and yield estimation of crops
9. Seed testing – germination test, viability test.
10. Techniques of weed collection and preservation

11-13. Identification of weeds in crops
14-15. Herbicide formulation and identification- Herbicide label information
16. Study of herbicide application equipment and calibration
17. Computation of herbicide doses, field practice of spraying herbicides and recording observations
18. Practical Examination

Suggested Readings

1. Balasubramaniyan, P and Palaniappan, S.P. 2001. *Principles and Practices of Agronomy*.AgroBios (India) Ltd., Jodhpur.
2. Brady, N.C. and Well, R.R. 2002.*The Nature and Properties of Soils* (13th ed.). Pearson Education, Delhi.
3. De, G.C.1989.*Fundamentals of Agronomy*. Oxford & IBH Publishing Co., New Delhi.
4. Gupta, O.P. 2000. *Weed Management - Principles and Practices*. Agrobios (India) Ltd., Jodhpur
5. 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.
6. KAU [Kerala Agricultural University]. 2016. *Package of Practices Recommendations*. Kerala Agricultural University, Thrissur.
7. Rao, V.S. 2000. *Principles of Weed science*. Oxford & IBH Publishing Co. New Delhi.
8. Reddy.T.Y and Reddy, G.H.S.1995.*Principles of Agronomy*, Kalyani Publishers, Ludhiana.
9. Reddy.S.R.1999. *Principles of Agronomy*, Kalyani Publishers, Ludhiana.
10. Sankaran, S. and SubbiahMudaliar, V.T. 1991.*Principles of Agronomy*.The Bangalore Printing & Publishing Co., Bangalore
11. Thomas, C.G. and Abraham, C.T. 1998. *Common Weeds of Rice Ecosystem and their Management*. Kerala Agricultural University, Thrissur
12. Thomas, C.G. and Abraham, C.T. 2007.*Methods in Weed Science*. Kerala Agricultural University, Thrissur

2. Agro 1102 Agricultural Heritage (1+0)) (Agronomy & Agrl. Extension)

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

Lecture schedule

1. Agriculture scope- Importance of agriculture and agricultural resources available in India; Agriculture as an art, science and business- Branches of agriculture and their relationships.
2. Origin of agriculture- Hearths of domestication- Crop voyage in India and world; Columbian exchange
3. Agriculture systems in the world: hunting and gathering- shifting cultivation, settled agriculture, plantation agriculture, Mediterranean agriculture, homestead agriculture, truck gardening, large-scale grain farming, recessional farming, pastoral nomadism, livestock ranching, commercial livestock fattening, commercial dairying, etc.
4. Introduction to Indian agricultural heritage- Ancient agricultural practices
5. Relevance of heritage to present day agriculture- Past and present status of agriculture and farmers in society-
6. Journey of Indian agriculture and its development from past to modern era - Plant production and protection through indigenous traditional knowledge;
7. Chronology of agricultural technology development in modern India- Natural calamities and famines
8. Second world war and its effects on food production-Grow More Food Campaign and its effects.
9. Green revolution-Genesis-Basic elements-Criticisms- Lifeboat ethics and carrying Capacity

Mid Term Examination

10. Crops and their significance- major classification systems
11. National agriculture setup in India; ICAR institutes and SAUs
12. International Agricultural Research- CGAIAR and other International Institutions
13. Current scenario of Indian agriculture- Food security- Area and production of major crops-
14. Indian agricultural concerns and future prospects.
15. Introduction to gender perspectives in agriculture - gender concepts- gender in social institutions- society and patriarchy - multiple roles of women- practical and strategic gender needs.
16. Women in agriculture-Gender roles and division of labour- women's access and control on farm resources - gender issues and gender impacts in agriculture - multifaceted roles and tasks of farm women- gender, poverty and livelihoods
17. Gender equity and strategies for rural women's empowerment - farm women inclusive institutions and development programmes- women farmers, farm workers, farm entrepreneurs - women's collectives and self- help groups
18. Women friendly agricultural technologies and enterprises-farm mechanization and women- occupational health hazards- drudgery reduction for farm women- ergonomical approaches- technological options

Suggested Readings

1. Ahmed, S. 2004. *Gender Issues in Agricultural and Rural Livelihoods*-Vol. I M.S. Swaminathan Research Foundation, Chennai and Kerala Agricultural University, Thrissur.
2. Commonwealth Secretariat.1996. *Women and Natural Resource Management: A Manual for the Asian Region*. Gender and Youth Affairs Division, London.
3. Cox, G.W and Atkins, M.D. 1979. *Agricultural Ecology : An Analysis of World Food Production Systems.* W.H. Freeman and Company, San Francisco.
4. Grigg, D.B. 1974. *The Agricultural Systems of the World: An Evolutionary Approach.* Cambridge University Press, Cambridge.
5. Harlan, J.R. 1992. *Crops and Man*. American Society of Agronomy& Crop Science Society of America, Madison, WI.
6. Janick, J., Schery, R.W., Woods, F.W. and Ruttan, V.W. 1974. *Plant Science: An Introduction to World Crops*. W.H. Freeman and Company, San Francisco.
7. 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.
8. Pandey, H. 2002. *Women in Agriculture*. National Research Centre for Women in Agriculture (ICAR), Bhubaneswar.
9. Purseglove, J.W. 1974. *Tropical Crops: Dicotyledons*. The English Language Book Society and Longman, London 12
10. Randhawa, M.S. 1980-1986. *A History of Agriculture in India* Vol.I to IV Indian Council of Agricultural Research, New Delhi.
11. Samantha R.K (ed.). 1995. *Women in Agriculture-Perspectives, Issues and Experiences*. M.D.Publishers, New Delhi

3. Agro 1203. Irrigation and water management (1+1)

Theory

Irrigation: definition and objectives. Role of water in soil and plants-Water resources and irrigation development in India and Kerala.Soil–plant-water-relationships.Soil moisture constants.Evapo-transpiration, potential evapo-transpiration and consumptive use, Reference crop evapo-transpiration (ETo)- Crop co-efficient (Kc)- Kc values for different crops. Main empirical methods of calculation of ETo- 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 Kerala. 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

Lecture schedule

1. Irrigation- definition- agricultural water management- water management and watershed management- rainfed agriculture and irrigated agriculture- Role of water in soil and plants
2. Water resources- surface and ground water resources- Nature of ground water- Conjunctive use of water- hydrologic cycle- virtual water- integrated water resources management
3. Nature of soil water- Soil moisture tension and soil water potential- Components of soil water potential
4. Soil moisture constants- classification of soil water- Soil moisture and its characteristics- Soil moisture deficit-
5. Entry of water into soil- infiltration, percolation, seepage, interflow- soil water movement- Darcy's law- soil moisture measurements
6. Soil- plant water relationships- factors influencing plant water relationships – water as a plant component- effective root zone depth- moisture extraction pattern-water potential in plant cells - Water movement along soil-plant-atmosphere continuum
7. Crop water use- evapo-transpiration and consumptive use- potential evapo-transpiration (PET) and referencecrop evapo-transpiration (ETo) - Crop co-efficient (Kc), Kc values for different crops.
8. Estimation of ET by different methods- Pan evaporimeter - crop factor-lysimeters- field plot technique- Main empirical methods of calculation of ETo- CROPWAT model
9. Water requirement of crops- water requirement and irrigation requirement- methods of determining total water requirement-effective rainfall-duty and delta

Mid Term Examination

10. Scheduling irrigation –principles of scheduling irrigation- depth of irrigation- effective root depth- allowable depletion volume of water
11. Criteria for scheduling irrigation- different approaches- soil moisture status- physiological and critical stages- Climtological approaches- water balance accounting method
12. Methods of irrigation- surface irrigation-flooding, border and basin irrigation, furrow and surge irrigation. Subirrigation
13. Overhead irrigation- Sprinkler irrigation-Micro irrigation- Drip irrigation-micro sprinklers, jets, and bubbler irrigation
14. Irrigation efficiency- Water productivity and water use efficiency--factors affecting water productivity-Agronomic techniques to improve water productivity
15. Suitability of irrigation water – Problems associated with the use of poor quality irrigation water, Irrigation water quality criteria and its management, Classification of crops based on salt tolerance, Leaching requirement- Methods of leaching
16. Water management of principal crops- critical stages of crop, depth and schedule of irrigation of rice, wheat, maize, sugarcane, ground nut, sesame, coconut, banana, pepper, cardamom, and vegetables
17. Agricultural drainage-Need and benefits of drainage, Effects of water logging, causes of water logging and drainage coefficient
18. Surface and subsurface drainage systems

Practical schedule

1. Basic calculations for water management
2. Determination of bulk density, porosity
3. Determination of soil moisture by thermo-gravimetric method and volumetric methods
4. Determination of soil moisture by tensiometer
5. Electrical resistance blocks, Neutron moisture meter
6. Determination of field capacity
7. Permanent wilting point
8. Infiltration rate
9. Measurement of irrigation water using orifices, weirs, and Parshall flumes
10. Calculation of consumptive use using soil moisture depletion data

11. Use of Open Pan Evaporimeter for scheduling irrigation to crops
12. Scheduling irrigation based on water balance accounting method
13. Computation of irrigation requirement of crops, irrigation interval and irrigation efficiency.
14. Computation of irrigation requirement of crops, irrigation interval and irrigation efficiency.
15. Methods of irrigation – border strip, check basin, furrow.
16. Operation of sprinkler, drip, and fertigation systems, operation of various micro irrigation systems
17. Visit to a water management research station
18. Practical Examination

Suggested Readings

1. Allen, R.G., Pereira, L.S., Raes, D. and Smith, M. 1998. *Crop Evapotranspiration—Guidelines for Computing Crop Water Requirements*, FAO Irrigation and Drainage Paper 56. Food and Agriculture Organization of the United Nations, Rome
2. Brouwer, C., Prins, K., Kay, M. and Heibloem, M. 1985. *Irrigation Water Management. Introduction to Irrigation.* Training manual No.1. FAO, Rome. Available: http//fao.org/docrep/S8684E
3. Brouwer, C., Prins, K, Kay, M., and Heibloem, M.1986. *Irrigation Water Management: Irrigation Water Needs.* Training Manual No 3 .FAO, Rome
4. Brouwer, C., Prins, K., Kay, M. and Heibloem, M. 1989. *Irrigation Water Management. Irrigation Scheduling.*Training manual No.4. FAO, Rome.
5. Brouwer, C., Prins, K, Kay, M., andHeibloem, M.1989. *Irrigation Water Management: Irrigation Methods.* Training Manual No 5 .FAO, Rome
6. Dastane, N.G. 1972. *A Practical Manual for Water Use Research in Agriculture* (2nd Ed). NavabharathPrakashan, Poona, 120p.
7. Doorenbos, J., and Kassam, A.H. 1979. *Yield Response to Water*. FAO Irrigation and Drainage Paper 33. Food and Agricultural Organisation of the United Nations, Rome
8. Doorenbos, J., and Pruitt, W.O. 1977. *Guidelines for Predicting Crop Water Requirements.* FAO Irrigation and Drainage Paper 24. Food and Agricultural Organisation of the United Nations, Rome
9. Kramer, P.J. 1983. *Water Relations of Plants.* Academic Press, San Diego, USA, 489p.
10. Lenka, D. 2005. *Irrigation and Drainage* (3rd Ed.). Kalyani Publishers, Ludhiana, 327p.
11. Michael, A.M. 2007. Irrigation Theory and Practice (2nd Ed.). Vikas Publishing House Pvt. Ltd., New Delhi.
12. Misra, R.D. and Ahmed, M. 1987. *Manual on Irrigation Agronomy.* Oxford & IBH, New Delhi, 412p.
13. Prihar, S. S. and Sandhu, B. S. 1987. *Irrigation of Field Crops.* Indian Council of Agricultural Research, New Delhi, 142p.
14. Sankara Reddi, G.H. and Yellamananda Reddy, T. 2003. *Efficient Use of Irrigation Water.*Kalyani Publishers, Ludhiana, 492p.
15. Stern, P. 1979. *Small Scale Irrigation*. *A Manual of Low Cost Water Technology*. Intermediate Technology Publications Ltd. London, 152p.
16. Thomas, C.G. 2010. Land Husbandry and Watershed Management. Kalyani Publihses, Ludhiana, 716p.

4. Agro 2104 Crop Production Technology-I (Cereals, millets, tuber and fodder crops) 1+1

Theory

Origin, geographical distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of rice, wheat, maize,cassava and sweet potato ,economic importance of

millets, economic importance and general cultivation aspects of yams, aroids, guinea grass and hybrid Napier

Practical

Identification and familiarization of cereals and millets, tuber crops and fodder crops – Preparation of wet, dry and mat nurseries for rice and transplanting –Calculations on seed rate and fertilizer requirements of major crops- Preparation of planting material of major crops - Seed treatment – Land preparation and planting – After cultivation operations- identification of weeds , top dressing and foliar feeding of nutrients – Study of yield contributing characters and yield calculations– Harvesting – Computation of cost of cultivation - Visit to field of agronomic experiments and research centers of related crops.

Lecture schedule

1. Importance of cereals and millets, differences between cerealsand millets, important tropical and temperate cereals and millets.
2-5. Rice - Origin, geographical distribution, economic importance, botany and growth phases, soil and climatic requirements, varieties, cultural practices,systems of cultivation, harvesting and processing
6-7. Wheat - Origin, geographical distribution, economic importance, botany andgrowth phases, soil and climatic requirements, varieties, cultural practices,harvesting
8- 9. Maize - Origin, geographical distribution, economic importance, botany andgrowth phases,soil and climatic requirements, varieties, cultural practices,harvesting.

Mid Term Examination

10. Sorghum, pearl millet and finger millet and minor millets– Economic importance
11. Importance of tuber crops, important major and minortuber crops
12-14. Tapioca - Origin, geographical distribution, economic importance, botany andgrowth phases, soil and climatic requirements, varieties, cultural practices,
harvesting and processing
15-16. Sweet potato - Origin, geographic distribution, economic importance, botany andgrowth phases, soil and climatic requirements, varieties, cultural practices,harvesting.
17. Yams and aroids- economic importance and general cultivation aspects
18. Agrostology -definition – Importance in live stocknutrition , classification of fodder crops,Guinea grass and Hybrid Napier- general cultivation aspects

Practical schedule

1. Identification and familiarization of cereals and millets
2. Identification and familiarization of tuber crops
3. Identification and familiarization of forage crops
4. Problems on seed rate and fertilizer requirements of major crops
5. Preparation of planting materials of major crops - Seed treatment
6-7. Land preparation and planting of major crops
8- 9. Preparation of wet, dry and mat nurseries for rice and transplanting
10-12. After cultivation operations of major crops- identification of weeds, top dressing and foliar feeding of nutrients
13-14. Growth and yield measurements- study of yield contributing characters and yield calculation
15. Harvesting of major crops.
16. Computation of cost of cultivation
17. Visit to field of agronomic experiments/ research center of related crops
18. Practical Examination

Suggested Readings

1. Chatterjee, B.N. 1989. *Forage Crop Production- Principles & Practices*. Oxford &IBH .New Delhi.
2. Chatterjee, B.N. and Maiti, S.1985. *Principles and Practices of Rice Growing*.Oxford &IBH Publishing Co., New Delhi.
3. Singh, C., Singh, P., and Singh, R. 2003. *Modern Techniques of Raising FieldCrops* (2nd ed.). Oxford &IBH , New Delhi.
4. De Datta, S.K. 1981. *Principles and Practices of Rice Production*. John Wiley & Sons, New York.
5. Gutteridge, R.C and Shelton, H.M. (eds.).1998 *Forage Tree Legumes in TropicalAgriculture*.Tropical Grassland Society of Australia Inc.
6. ICAR [Indian Council of Agricultural Research].2013.*Hand Book of Agriculture*. ICAR,New Delhi
7. KAU [Kerala Agricultural University].2016.*Package of Practices Recommendations – Crops*. Directorate of Extension, Kerala Agricultural University, Thrissur
8. Mohankumar, C.R., Nair, G.M., James George., Raveendran. C.S. and Ravi. V. 2000.*Production Technology of Tuber Crops*. C.T.C.R.I, Trivandrum
9. Narayanan, T.R. and Dobadghao, P.M. 1972. *Forage Crops of India*, ICAR, New Delhi.21
10. Onwueme, I. C. and Charles.W.D . 1994. *Tropical Root and Tuber Crops – Production, Perspective and Future Prospects*.F.A.O. Production and Protection Paper-126, Rome.
11. Pal, M., Deka, J.and Rai, R.K. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill Pub., New Delhi
12. Prasad, R. (ed.). 1999. *A Text Book of Rice Agronomy*, Jain Brothers, New Delhi,
13. Prasad, R. (ed.). 2001. *Field Crop Production*. ICAR, New Delhi
14. Purseglove, J.W. 1974. *Tropical Crops: Dicotyledons*. The English Language Book Society and Longman, London
15. Purseglove, J.W. 1975. *Tropical Crops: Monocotyledons.* The English Language Book Society and Longman, London
16. Thomas, C. G. 2003. *Forage Crop Production in the Tropics*. Kalyani Publishers, Ludhiana

5. Agro. 2205 Crop production Technology– II (Pulses, oilseeds, sugar and fibre crops) 1+1

Theory

Origin, geographical distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of chick pea, cowpea, groundnut, sesamum, soybean,sugar cane and cotton - Economic importance and general cultivation aspects of red gram, black gram, green gram, sunflower and jute

Practical

Identification and familiarization of pulses, oilseeds, sugar crops, fibre crops and narcotics– Problems on seed rate, fertilizer requirements - Preparation of planting material of major crops - Seed treatment – Land preparation and planting – After cultivation operations — Study of yield contributing characters and yield calculations– Harvesting – Juice quality analysis of sugar cane- Computation of cost of cultivation - Visit to field of agronomic experiments and research centres of related crops.

Lecture schedule

1. Importance and classification of pulses- role in human nutrition and soil fertility, Production constraints and strategies to overcome them

2-3. Chick pea - Origin, geographical distribution, economic importance, botany and growth phases,soil and climatic requirements, varieties, cultural practices, harvesting
4. Cow pea- Origin, geographic distribution, economic importance, botany and growth phases, soil and climatic requirements, varieties, cultural practices, harvesting
5. Red gram, Black gram and green gram - economic importance and general cultivation aspects
6. Importance and classification of oil seeds. Production constraints and strategies to overcome them.
7-8. Groundnut - Origin, geographical distribution, economic importance, botany and growth phases, soil and climatic requirements, varieties, cultural practices, harvesting.

Mid Term Examination

9-10. Sesame - Origin, geographical distribution, economic importance, botany and growth phases, soil and climatic requirements, varieties, cultural practices, harvesting
11. Soybean - Origin, geographical distribution, economic importance, botany and growthphases, soil and climatic requirements, varieties, cultural practices, harvesting
12. Sunflower- economic importance and general cultivation aspects
13-15. Important sugar yielding crops- Sugarcane - Origin, geographical distribution, botany and growth phases, soil and climatic requirements, varieties, cultural practices, ratooning, harvesting-quality parameters-processing- by-products
16-17. Cotton- Origin, geographical distribution, economic importance, botany and growth phases, soil and climatic requirements, varieties, cultural practices, harvesting- qualitparameter
18. Jute- economic importance and general cultivation aspects

Practical schedule

1. Identification and familiarization of pulse crops
2. Identification and familiarization of oilseeds
3. Identification and familiarization of sugar crops
4. Identification and familiarization of fibre crops, tobacco, and betel vine.
5. Problems on seed rate and fertilizer requirements of major crops
6. Preparation of planting material of major crops - Seed treatment – *Rhizobium* inoculation of leguminous crops
7-9. Land preparation and planting of major crops
10-12. After cultivation operations of major crops
13-14. Harvesting of major crops- Study of yield contributing characters and yield calculations
15. Quality assessment in sugarcane
16. Computation of cost of cultivation
17. Visit to field of agronomic experiments and research centres of related crops.
18. Practical Examination

Suggested Readings

1. Agarwal, P.C. 1990. *Oilseeds in India*. Oxford and IBH, New Delhi
2. Balasuramaniyan, P. and Palaniappan, S.P. 2003. *Principles and Practices of Agronomy*. Agrobios(India)
3. Barnes, A.C. 1964. *The Sugarcane*.Interscience Publishers, New Delhi
4. Das, P.C. 1997. *Oilseed Crops of India,* Kalyani Publishers., New Delhi.
5. ICAR [Indian Council of Agricultural Research].2013.*Hand Book of Agriculture*. ICAR,New Delhi
6. KAU [Kerala Agricultural University].2016.*Package of Practices Recommendations –Crops*. Directorate of Extension, Kerala Agricultural University, Thrissur
7. Lekshmikantan, M. 1983. *Technology in Sugarcane Growing.*Oxford & IBH PublishingCo., Pvt. Ltd., New Delhi

8. Prasad, R. (ed.). 2001. *Field Crop Production*. ICAR, New Delhi
9. Purseglove, J.W. 1974. *Tropical Crops: Dicotyledons*. The English Language BookSociety and Longman, London
10. Purseglove, J.W. 1975. *Tropical Crops: Monocotyledons.* The English Language BookSociety and Longman, London
11. Singh,C., Singh, P., and Singh, R. 2003. *Modern Techniques of Raising FieldCrops* (2nd ed.). Oxford & IBH Publishing Co , New Delhi.
12. Yadav, D.S. 1992. *Pulse Crops*. Kalyani Publishers.,

6. Agro 3106 - Farming system and sustainable agriculture - 1+0

Theory

Farming System- importance, and concept, Types and systems and factors affecting types of farming- Farming system components - Cropping system and pattern, multiple cropping system, Plant Interactions- Efficient cropping systems and their evaluation, allied enterprises and their importance- Cropping systems of Kerala -Rice based, Coconut based systems- Agro forestry - Tools for determining production and efficiencies of cropping systems-; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies, HEIA, LEIA and LEISA, ecological principles of LEISA and promising techniquesfor sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific IFS models for agroclimatic zones- resource use efficiency and optimization techniques- Resource cycling and flow of energy in different farming system, Homestead farming systems- Good Agricultural Practices, ITKs and farmer centered techniques and practices- Visit to IFS model in different agroclimatic zones of state university/institute/famers' fields

Lecture schedule

1. Farming System- scope, importance and concept- Types and systems and factors affecting types of farming
2. Farming system- components and features-cropping system and pattern-terms and definitions
3. Multiple cropping systems – intercropping- ecological basis of intercropping- types
4. Sequential cropping-crop rotation- parallel cropping-companion cropping- mulch farming-catch cropping- contingency cropping- cover cropping
5. Plant interactions- allelopathy- annidation-competition
6. Evaluation of cropping systems- Criteria for assessment of yield advantage- LER, RYT, LEC, RCC, Aggressivity, Competition Index, Crop Equivalent Yield, Multiple Cropping Index
7. Cropping Systems in Kerala- Rice based cropping systems
8. Coconut based cropping systems- multitier cropping pattern
9. Agro forestry- major agroforestry practices

Mid Term Examination

10. Allied enterprises and their importance- Integrated farming system-historical background, objectives and characteristics
11. Components of IFS and its advantages-Resource cycling and flow of energy in different farming systems
12. Resource use efficiency and optimization techniques- IFS models for agroclimatic zones
13. Homestead farming systems- scope-components- sustainable practices
14. Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation
15. Conservation agriculture strategies, HEIA, LEIA and LEISA, ecological principles of LEISA
16. Promising techniquesfor sustainability, improved manure handling-crop residue management-strategic use of fertilizers and pesticides-water conservation measures

17. Good Agricultural Practices, ITKs and farmer centered techniques and practices
18. Visit to IFS models in different agroclimatic zones of state university/institute/famers' fields

Suggested Readings

1. Balasubramaniyan, P. and Palaniappan, S.P. 2001. *Principles and Practices of Agronomy.* Agrobios Publishers, Jodhpur
2. Chatterjee, B.N., Maiti, S. and Mandal, B.K. 1989. *Cropping Systems - Theory and Practice*. Oxford and IBH Publication, New Delhi
3. Francis, C.A. 1986. *Multiple Cropping Systems*. Macmillan Publication
4. Francis, C.A. 1989. Biological efficiencies in multiple cropping systems.*Advances in Agronomy*, 42.1-42.
5. Gomez, A.A. and Gomez, K.A. 1983. *Multiple Cropping in the Humid Tropics of Asia*. International Development Centre (IDRC),Ottawa.
6. Karlen, D.l., Varvel, G.E., Bullock, D.G. and Cruse, R.M. 1994 Crop rotations for the 21st century. *Advances in Agronomy*, 53.1-45.
7. Nair, P.K.R. 1993. *An Introduction to Agroforestry*. Kluwer, Netherlands.
8. Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping Systems in the Tropics: Principles and Management*. New Age India (P) Ltd.,
9. Panda, S.C. 2003.*Cropping and Farming Systems*.Agrobios Publishers, Jodhpur26
10. Papendick, R. I., Sanchez, P.A. and Triplett, G.B. *(eds).* 1976 *Multiple cropping*. American Society of Agronomy Special Publication No.27.Madison, Wisconsin.
11. Pathak, PS. and Roy M.M. 1994.*Agroforestry Systems for Degraded Lands.*Oxford& IBH Publishing, New Delhi.
12. Raman, K.V. and Balaguru, T. 1992. *Farming systems Research in India: Strategies for Implementation*.Pragati Art Printers, Hyderabad, India.
13. Rangasamy, A.K., Annadurai., Subbiyan, P. and Jayanthi, C. 2002. *Farming System in the Tropics.*Kalyani Publishers, Ludhiana
14. Tejwani, K.G. 1994. *Agroforestry in India*, Oxford & IBH Pub., New Delhi.

7. Agro. 3107 Practical Crop Production – I (Rice and Tuber crops) (0+2)

Practical

Crop planning, Nursery raising: land preparation, seed treatment, sowing,water management, integrated nutrient management and plant protection.Main field preparation, transplanting, water management, integrated nutrient management, weed management and plant protection. Harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8 to 10 students

Practical schedule

1 . Rice-Crop planning-Selection of site for nursery and main field
2. Nursery raising-land preparation, seed treatment, sowing
3. Water management, integrated nutrient management and plant protection in the nursery.
4-5. Preparation of main field- strengthening bunds- ploughing- puddling
6-7. Organic manure application, basal dose of fertilizers and transplanting
8-9. Top dressing of fertilizers, water management
10-11. Identification of weeds in the field and integrated weed management
12-13. Identification of pests and diseases and integrated plant protection
14-17. Harvesting, threshing, drying, winnowing, storage and marketing of produce
18. Preparation of balance sheet-Cost benefit analysis
19-20. Tuber crops in various cropping systems- crop planning
21-24. Preparation of planting material, field preparation and planting of cassava and sweet potato

25-28. Integrated nutrient management for cassava and sweet potato
29-30. Identification of weeds in the field and integrated weed management
31-32. Identification of pests and diseases and integrated plant protection
33-34. Harvesting, storage and marketing of produce
35. Preparation of balance sheet-Cost benefit analysis
36. Practical Examination

Suggested Readings

1. De Datta, S.K. 1981. *Principles and Practices of Rice Production*. John Wiley & Sons, New York.
2. KAU [Kerala Agricultural University].2016.*Package of Practices Recommendations – Crops*.Directorate of Extension, Kerala Agricultural University, Thrissur, 360 p.
3. Mohankumar, C.R., Nair, G.M., James George., Raveendran. C.S. and Ravi. V. 2000. *Production Technology of Tuber Crops*. C.T.C.R.I, Trivandrum

8. Agro. 3208 Practical Crop Production – II (Pulses and oilseeds) (0+1)

Practical

Crop planning, field preparation, sowing, water management, integrated nutrient management, weed management and plant protection. Harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8 to 10 students

Practical schedule

1 . Crop planning-Selection of site for Pulses and oilseeds
2-8. Land preparation, seed treatment, sowing of pulses and oilseeds
9-10. Integrated nutrient managementandwater management
11-12. Identification of weeds in the field and integrated weed management
13-14. Identification of pests and diseases and integrated plant protection
15-16. Harvesting, threshing, drying, winnowing, storage and marketing of produce
17. Preparation of balance sheet-Cost benefit analysis
18. Practical Examination

Note: In addition to practical hours, for certain time bound operations; the students will complete the work after the regular class hours.

Suggested Readings

1. ICAR [Indian Council of Agricultural Research].2013.*Hand Book of Agriculture*. ICAR, New Delhi
2. KAU [Kerala Agricultural University].2016.*Package of Practices Recommendations – Crops*. Directorate of Extension, Kerala Agricultural University, Thrissur, 360 p.
3. Singh,C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Field Crops* (2nd ed.). Oxford & IBH Publishing Co , New Delhi.

9. Agro 3209 Rainfed Agriculture and Watershed Management 1+1

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 developed watersheds**.**

Lecture schedule

1. Rainfed Agriculture–definition- types- irrigated agriculture and rainfed agriculture-characteristics of rainfed agriculture
2. History of rainfed agriculture and watershed management in India.Problems and prospects of rainfed agriculture in India
3. Soil and climatic conditions prevalent in rainfed areas-
4. Vagaries of monsoon, late onset, early withdrawal of monsoon, prolonged dryspells, soil constraints-
5. Problems of soil erosion in rainfed areas- slopes and contours- factors influencing erosion-USLE-practical implications-
6. Soil and water conservation-agronomic measures-choice of crop, contour farming-conservation tillage, cover cropping, strip cropping, mulching, organic manures, croppingsystem, hedge row intercropping-SALT-use of geotextiles
7. Mechanical measures-terraces and bunds- contour bunds- rubble pitched bunds-bench terraces, Puerto Rican terraces- conservation bench terraces
8. Intermittent terraces, contour trenches, stream bank protection measures
9. Land capability classification and rainfed areas

Mid Term Examination

10. Drought-definition,classification,periodicity,effect of water deficit on physio-morphological characteristics of plants,
11. Crop adaptation to drought- drought mitigation strategies-
12. Management of crops in rainfed areas,
13. Contingent crop planning for aberrant weather conditions,preparation of appropriate crop plans for rainfedareas,midseason correction
14. Water harvesting: importance and various techniques, Efficient utilization of water through soil and crop management practices,
15. WatershedManagement-definition,classification of watershed- importance of small watersheds- watershed area and command area- principle,objectives,and characteristics-
16. Data collection and preparation of watershed management plan-
17. Steps and components of watershed management,
18. Watershed management programmes in India and Kerala(eg. IWMP) .

Practical schedule

1. Terminologies in rainfed agriculture

2. Rainfall analysis
3. Studies on rainfall pattern and understanding the rainfall distribution pattern over years
4. Working out drought years from rainfall data.
5. Studies on cropping pattern of rainfed areas and demarcation of rainfed areas on map of India
6. Studies on cropping pattern of rainfed areas and demarcation of rainfed areas on map of India
7. Determination of slope using simple techniques
8. Determination of contour lines using simple techniques
9. Effective rainfall and its calculation
10. Effective rainfall and its calculation
11. Agronomic measures for soil conservation- demonstration of contour farming. Identification of cover crops- trees suitable for hedge row intercropping and SALT
12. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops
13. Field demonstration contour bund and rubble pitched contour bund
14. Intermittent terraces
15. Field demonstration on construction of low cost waterharvesting structures.
16. Delineation and mapping of watersheds
17. Visit to model watersheds
18. Practical Examination

Suggested Readings

1. De Barry, P.A. 2004. *Watersheds, Processes, Assessment and Management*. John Wiley and Sons, New Jersey, 700p.
2. Dhruvanarayana, V.V., Sastry, G. and Patnaik, U.S. 1990. *Watershed Management*. Indian Council of Agricultural Research, New Delhi, 176p.
3. Gupta, U.S. (Ed.) 1975. *Physiological Aspects of Dryland Farming*. Oxford and IBH, New Delhi, 391p. .
4. Gupta, U.S. 1995 *Production and Improvement of Crops for Drylands.* Oxford and IBH, New Delhi.
5. Singh, G., Venkataraman, C., Sastry, G. and Joshi, B.P. 1990. *Manual of Soil and Water Conservation Practices.* Oxford and IBH, New Delhi, 385p.
6. Hudson, N. 1981. *Soil Conservation* (2nd Ed.). Batsford Academic and Educational, London,.324p.
7. Hudson, N.W. 1992. *Land Husbandry.* Batsford, London, 192 p.
8. Katyal, J.C. and Farringtion, J.1995.*Research for Rainfed Farming*, CRIDA,Hyderabad
9. Roose, E. 1996. *Land husbandry- Components and Strategy*. FAO soils bulletin No.70. Food and Agriculture Organization, Rome, 380p.
10. Samra, J.S., Sharda, V.N. and Sikka, A.K. 2002. *Water Harvesting and Recycling: Indian Experiences*. Central Soil and Water Conservation Research and Training Institute. Dehra Dun, 347p.
11. Sheng, T.C. 1990. *Watershed Management Field Manual. Watershed Survey and Planning.* FAO Conservation Guide 13/6. Food and Agriculture Organization of the United Nations, Rome.
12. Thomas, C.G. 2010. *Land Husbandry and Watershed Management*. KalyaniPublihses, Ludhiana, 716p.
13. Wan, S.P., Rockstrom, J. and Sahrawat, K.L. 2011. *Integrated Watershed Management in Rainfed Agriculture,*CRC Press, 496p.
14. Wan, S.P., Rockström, J., and Oweis, T. (Eds). 2009. *Rainfed Agriculture: Unlocking the Potential.* CAB International , Wallingford, UK, 310p.

AGRICULTURAL METEOROLOGY

1. Agmt 1101 - Introductory Agro-meteorology & Climate Change (1+1)

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 sunshine duration. 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 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 windrose. Measurement, tabulation and analysis of rain. Measurement of evaporation. Analysis of rainfall pattern of Kerala, annual rainfall analysis, assessment of drought year.

Lecture schedule

1. Introduction to Meteorology and Agricultural Meteorology - Scope and importance of Agricultural Meteorology
2. Composition of Atmosphere - Role of greenhouse gases in global cooling and warming
3. Concept of weather and climate - Micro-meso-macro and phytoclimates
4. Electromagnetic Spectrum - Nature and properties of solar radiation – shortwave radiation and long wave radiation - Radiation balance
5. Response of plants to solar radiation and photosynthetically active radiation
6. Thermal structure of atmosphere - vertical profiles - factors affecting surface air temperature
7. Spatial and temporal variations in surface air temperature - soil temperature and its variations
8. Atmospheric pressure and its variation with height - Global distribution of pressure and wind
9. Atmospheric humidity - saturation and actual vapour pressure - relative humidity and dew point temperature

Mid Term Examination

10. Cloud classification and measurements - cloud seeding
11. Indian monsoons - southwest monsoon — northeast monsoon - monsoon variability across Kerala and India
12. Rainfall and its mechanisms — forms and types of rainfall — Rainfall over India and Kerala

13. Agricultural seasons — Importance of weather forecasting in Agriculture – weather service to farmers
14. Crop weather diagrams and calendars — crop weather relationships - Role of weather on insect pest and diseases
15. Weather and climate related natural disasters - risk and management
16. Weather modification
17. Climate change and global warming
18. Introduction to Remote Sensing

Practical schedule

1. Types of Agricultural Meteorological Stations
2. Selection of site and layout of agrometeorological stations
3. Meteorological and Agrometeorological Stations
4. Installation and exposure of meteorological instruments
5. Measurement of Air temperature
6. Installation of soil thermometers and measurement and recording of soil temperature
7. Measurement of Relative humidity and vapour pressure
8. Dew point temperature and dew fall
9. Identification and measurement of clouds
10. Measurement of wind speed and direction
11. Measurement of rainfall
12. Measurement of open pan evaporation
13. Sunshine Recorder and measurement of sunshine
14. Automatic Weather Station
15. Recording of weather data — tabulation-Processing and presentation Meteorological data
16. Recording of weather data — tabulation— Processing and presentation Meteorological data
17. Preparation of crop weather calendars
18. Practical Examination

Suggested Readings

1. Annette Bolger. 2010. *Science of Weather and Environment*. Oxford Book Company, Jaipur
2. Das,P.K. 1968. *The Monsoons*. NBT, New Delhi
3. Frederick.K.Lutgens, Edward.J.Tarbuck.1989.*The Atmosphere- An Introduction to Meteorology*. Prentice Hall, New Jersey
   Khadekar, S.R. 2001. *Meteorology*. Agromet publishers, Nagpur
4. Mavi, HS, 1986. *Introduction of Agrometeorolgy*. Oxford & IBH Publishing Co. New Delhi
5. Prasada Rao, G.S.L.H.V. 2005. *Agricultural Meteorology*. Second Edition. Kerala Agricultural University, Thrissur
6. Sachati, A.K. 1985. *Agricultural Meteorology — Instruction-cum-practical manual*, NCERT, New Delhi
7. Sellus, W.D. 2015. *Physial Climatology*. New India Publishing Agency, New Delhi
8. Varshneya, M.C. and Balakrishna Pillai, B. 2003. *Textbook of Agricultural Meteorology*. ICAR, New Delhi
9. Venketaraman, S. and Krishnan, A. 1992. *Crops and weather*. ICAR, New Delhi

SOIL SCIENCE & AGRICULTURAL CHEMISTRY

1. Ssac 1101 Fundamentals of Plant Biochemistry (1+1)

Theory

Biochemistry – Introduction scope, importance in Agriculture – Bio molecules –general groups – classification – important sugars - poly saccharides – structure properties stereochemistry – carbo hydrates – metabolism. Proteins and amino acids – classification – reactions – functions – properties plant proteins – nutritional significance protein metabolism – bio synthesis. Lipids – definition. Classification – saturated unsaturated fatty acids – biological importance – degradation & bio synthesis of fatty acids. Enzymes – definition, nomenclature – functions factors affecting enzyme activity. Vitamins – definition – classification source – function. Nucleic acids – general. Secondary metabolites – Alkaloids phenolic compounds - importance .

Practical

Qualitative tests and quantitative determination of sugars – proteins and lipids – characterization – chromatographic techniques. Ca determination in plant extract.

Lecture schedule

1. Review of biochemistry introduction – Biomolecules general groups – Importance – Characterization of biomolecules-techniques.
2. Carbohydrates –classification –properties and general reactions.
3. Important sugars structure –properties and stereochemistry-polysaccharides-storage and structural chemistry.
4. Amino acids and Proteins –classification, significance-general reactions-biological functions.
5. Peptides-Plant Proteins –Quality function.
6. Enzymes-chemistry, Nomenclature –classification-functions-properties-mechanism of action.
7. Enzyme Kinetics.
8. Enzymes-Factors affecting activity, immobilization and industrial application.
9. Vitamins-Definition, classification, source-biochemical function

Mid Term Examination

10. Fat and water soluble vitamins-structure and function.
11. Lipids-chemistry-classification, properties
12. Fatty acids –Classification-reaction
13. Physical and chemical tests-Fat constants-Oil quality.
14. Simple and complex Lipids and their significance in living system.
15. Metabolism of Carbohydrates –Anaerobic and Aerobic Cycles-biosynthesis of Carbohydrates.
16. Metabolism of Lipids-Oxidation of odd and even number Fatty acids-Biosynthesis of Fatty Acids and Protein.
17. Integration of carbohydrates, Lipid and Protein metabolism.
18. Secondary Metabolites-Classification, Properties, uses and applications –Alkaloids-Classification, structure, properties and significance.

Practical schedule

1. Separation of bio molecules by Electrophoresis.
2. Qualitative tests for Carbohydrates.
3. Mono and Disaccharides- Tests.
4. Polysaccharides-Qualitative Tests.

5. Estimation of Reducing and Non reducing sugars in sugarcane /jaggery.
6. Estimation of Starch.
7. Qualitative Test of Proteins and Amino acids –Precipitation reactions
8. Colour reactions of Amino acids.
9. Estimation of Amino acids, Proteins by colorimetry.
10. Extraction of oil.
11. Estimation of Fat constants.
12. Qualitative Tests for oils.
13. Chromatographic techniques of separation of Biomolecules.
14. Characterization of Lipids by TLC.
15. Estimation of Fatty Acids by GLC.
16. Estimation of Proteins in Pulses by Kjeldhal Method.
17. Estimation of Nucleic acids,estimation of Calcium in Plant HCl extract.
18. Practical Examination

Suggested Readings

1. Conn, E and Stumpf, P.K.1989.*Outlines of Biochemistry*. Wiley Eastern LTD.
2. Jain, L.2001.*Fundamentals of Biochemistry* .vth Edition,.S.Chand & company, New Delhi.
3. Lehninge, A.1984. *Principles of Biochemistry*, Published by CBS publishers and Distributors, New Delhi.
4. Mehta,S.L., Lodha,M.L and Sane P.V.1993.*Recent advances in plant biochemistry*. ICAR, New Delhi.
5. White, A and Handler P .1978.*Principles of Biochemistry*, Mc Graw Hill Publications, New Delhi.
6. Verma, S.K .2000 *A Text Book of Plant Physiology and Biochemistry*, S .Chand & company, NewDelhi-110055.

2. Ssac. 1102 Fundamentals of Soil Science (2+1)

Theory

Soil-Pedological and edaphological concepts -origin of the earth - earth's crust - composition. Rocks and minerals. Weathering - soil formation - factors and processes - 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 Kerala.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.

Lecture schedule

1. Soil – definition – earth -origin -earth crust, composition, pedological and edaphological approach
2. Rocks – different kinds of rocks, formation and classification
3. Soil forming minerals – primary, secondary, accessory minerals - classification
4. Weathering of rocks and minerals- types of weathering, factors affecting weathering
5. Soil formation – factors and processes of soil formation, soil development
6. Profile development and differentiation, horizons, factors influencing the profile development
7. Podzolization and laterization
8. Soil physical properties – soil texture, importance of soil texture, textural classification of soils
9. Particle size analysis -Stokes law – limitations and assumptions
10. Different methods of particle size analysis and textural group identification.
11. Soil structure – definition, classification
12. Aggregation of soil particles – factors controlling them
13. Soil consistency - Soil crusting
14. Particle density – bulk density and porosity – their importance on soil fertility, factors affecting them and manipulation
15. Soil compaction -Soil air – importance – composition – comparison with atmospheric air, factors affecting the composition of soil air – dynamics – importance
16. Soil temperature, heat flow- amount – and equations - factors controlling the soil temperature- Soil colour
17. Soil classification, need for classification, comparison of different systems of classification
18. Soil taxonomy and its characteristics

    Mid Term Examination
19. Soil survey-importance, objectives- different types -Land capability classification
20. Soils of India – Geological formation and soils of Kerala – characterization
21. Soil water-forms of soil water, energy concepts- retention dynamics and availability.
22. Soil moisture constants – Movement of soil water- saturated unsaturated
23. Infiltration – percolation - permeability – drainage – capillary movement.
24. Methods for determination of soil moisture
25. Soil colloids, properties of colloids, different kinds of colloids, role of colloids in soil fertility -flocculation, de-flocculation, conditions favoring flocculation and de-flocculation
26. Layer silicate clays – their genesis and source of charge.
27. Clay minerals- amorphous material – organic colloids- clay humus complexes -source of charges- Adsorption of ions
28. CEC – its importance – CEC and nutrient availability
29. AEC – Factors influencing ion exchange and its significance
    pH Concept, soil acidity reason for soil acidity, reserve acidity, active acidity - liming
30. Saline soils, reasons for salinity, characterization of saline soils, reclamation of saline soils
31. Saline alkali soils and non-saline alkali soils – characterization, amendments and reclamation
32. Soil organic matter – composition - properties - decomposability, influence on soil properties.
33. Humus fractions of soil Organic matter – carbon cycle - Transformation of organic matter – C:N ratio
34. Soil biology - soil organisms- their beneficial and harmful roles
35. Role of organic matter in maintaining the physical and chemical properties of soils – importance in plant nutrition.

Practical schedule

1. Determination of particle density, Determination of bulk density and porosity
2. Aggregate analysis
3. Soil moisture determination by different methods
4. Determination of Soil moisture constants - Field capacity, PWP
5. Soil strength - Modulus of rupture, Determination of water holing capacity
6. Particle size analysis of soils
7. Particle size analysis of soils textural identification
8. Measurement of soil temperature variations
9. Brief introduction to Analytical chemistry, Basic concepts and calculations
10. Familiarization of Various titrimetric analysis
11. Collection and preparation of soil samples
12. Determination of Organic C
13. Determination of soil pH, and electrical conductivity of soil
14. Hypothetical soil profile and examination of soil profile.
15. Total elemental analysis -Determination of total N
16. Determination of total P, K
17. Determination of CEC of soils,identification of rocks and minerals
18. Practical Examination

Suggested Readings

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
5. *Fundamentals of Soil Science*. Published by Indian Society of Soil Science, IARI New Delhi, 2002
6. Gupta, P.K. 2007. Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodpur
7. Jackson, M.L. 1973 *Soil Chemical Analysis*. Prentice hall of India, New Delhi
8. Jaiswal, P.C. 2006. *Soil, Plant and Water Analysis*. 2nd Edn. Kalyani Publishers, Ludhiyana
9. Page, A.L. 1982. *Methods of Soil Analysis*, Part II, ASA Madison, USA
10. Sehgal, J.2005. *Pedology – Concepts and Applications*. Kalyani Publishers New Delhi
11. Tisdale,S.L., Nelson,W.L.,Beaton, J.D. and Havlin, J.L. 1995. *Soil fertility and Fertilizers*. 5th Edn. Macmillan publishing company, USA

3. Ssac 1203 Manures, Fertilizers and Soil fertility management (2+1) (SS&AC and Agronomy)

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.

Lecture schedule

1. Importance and scope of organic farming-Types of organic manures- sources- Bulky manures/ concentrated manures/liquid manures/green manures and green leaf manures.
2. Preparation techniques of different types of manures-role in soil fertility management
3. Chemical fertilizers – classification-Nitrogenous fertilizers – Urea, Ammonium sulfate-manufacturing process, properties and use
4. Nitrogenous fertilizers – Sodium nitrate, ammonium chloride, calcium ammonium nitrate, ammonium nitrate, ammonium sulfate nitrate manufacturing process, properties and use, Suitability of different nitrogenous fertilizers for different soils and crops
5. Phosphatic fertilizers – classification, manufacturing process, property and use of single super phosphate, triple super phosphate and bone meal
6. Phosphatic fertilizers – basic slag, rock phosphate, dicalcium phosphate manufacture, properties and use. Behavior of phosphatic fertilizers in different soil types and comparative fertilizer value of various phosphatic fertilizers
7. Principles of manufacture of potassic fertilizers, physical and chemical properties in relation to their use in various soils
   Quiz
8. Straight vs complex fertilizers. Manufacturing process, efficiency, properties and use of the recent complex fertilizers. Unit value and evaluation of fertilizers. Materials supplying secondary nutrients and micro nutrients and chelating compounds.

9-10. Fertilizer control order and specifications of fertilizers Amendments

11. Soil acidity – liming materials and its reaction in acidic soils. Liming materials – methods for evaluating the efficiency and the lime requirement. Saline and alkali soils – amendments for reclamation and soil conditioners
12. Soil as a source and storehouse of nutrients-soil fertility vs productivity and factors.
13. History and development of soil fertility studies. Arnon's criteria and different forms of nutrients-Essential and beneficial elements in plant nutrition
14. Forms of nutrient in soil and factors affecting availability of nutrients-Mechanism of nutrient transport to plant roots – ion uptake and ionic status of plants nutrient absorption – Carrier theory
15. Ion pumps - Active and passive transport - ion antagonism and synergism
16. Metabolic functions of elements in plants
17. Soil fertility – different approaches for soil fertility evaluation-chemical /biological/tracer
18. Chemical methods –Soil testing -Critical level of nutrients in soils- Colwell approach
    Mid Term Examination
19. Tracer techniques and EUF for soil fertility evaluation – Fertilizer tagging techniques – Use of N15 and P32
20. Soil test based fertilizer recommendation to crops(STCR)- targeted yield equations
21. Chemical methods –plant analysis – DRIS -Critical levels in plants - Rapid tissue tests – Indicator plants - Leaf colour chart - SPAD meter

22. Biological methods and recent trends in soil fertility evaluation-SSNM-
23. Remote sensing for crop N status- precision farming- GIS applications in agriculture
24. Nutrient use efficiency (NUE) – Concepts–factors influencing NUE in respect of N, P,K, S, Fe and Zn fertilizers.
25. Chemistry of soil nitrogen- phosphorus /potash/secondary and miro nutrients- interactions in soils.
26. .Nutrient cycles in soils – Nitrogen cycle – atmospheric N, plant and animal organic N, ammonification, nitrification and denitrification
27. Nitrogen fixation, non symbiotic and symbiotic-Role of blue green and azolla Nitrogen fixation – Major reactions involved in n fixation
28. Phosphorus transformation in soil- p cycle – organic and inorganic forms of P – rock phosphate sediments, release of P in soil.
29. Dynamics of Potassium in soil-forms- reactions in soils
30. Sulphur cycle – organically bound sulphur, oxidation under aerobic conditions, role of chemotrophic bacteria.
31. Chemical and biochemical implications of different nutrient cycles in soil fertility
32. Sources, method and scheduling of nutrient for different soils and crops grown under rainfed and irrigated condition-
33. Integrated nutrient management- IPNS- concepts- approaches- practical utility
34. Nutrient balance sheet- -indicator plants
35. Nutrient management planning
36. STCR based fertilizer recommendation

Practical schedule

1. Introduction to Analytical Instruments.
2. Principles of pH meter ,Conductivity meter, colorimeter and flame photometers (AES & AAS)
3. Preparation of soil samples for analysis
4. Determination of pH and electrical conductivity in soil
5. Estimation of organic carbon by Walkley and Black method
6. Determination of available nitrogen in soil
7. Determination of available phosphorus in soil
8. Determination of available potassium in soil
9. Determination of available Sulphur in soil
10. Determination of available micronutrients in soil –Zn ,Mn
11. Determination of exchangeable cations in soil
12. Determination of Lime requirement and Gypsum requirement
13. Soil test interpretation and fertilizer recommendations
14. Collection and preparation of plant samples for analysis
15. Dry ashing of plant material and Wet digestion of plant material
16. Determination of N in plant sample,determination of P in the plant material
17. Determination of K in the plant material,determination of S in plants
18. Practical Examination

Suggested Readings

1. Burges, A, and Raw, F. 1967. *Soil Biology. Acad.Press, New York*
2. Donahu, L. R., Miller, W. R. and Shickuluna, 1977. *Soils. Prentice Hall of India Pvt. Ltd., New Delhi*
3. Gupta, P.K. (1999) *Hand book of Soil, Fertilizer and Manure*. Agro Botanica, Bikaner
4. Gupta,A.K. (2007) *Methods in Environmental Analysis of Water , Soil and Air*. 2nd Edn. Published by Agrobios (India) Jodpur
5. Mengel, K.J. and Kirkby, A. 1978. *Principles of Plant Nutrition. International Potash Institute, Switzerland*

6. Nyle.C. Brady 1995. *The Nature and Properties of Soils. 10th Edn. Printice Hall India pvt. Ltd. New Delhi*
7. Raymond W Miller and Roy L. Donahue. 1992. *Soils and Introduction to Soils and Plant Growth.* 6th edn. Printice Hall India pvt. Ltd. New Delhi
8. Robert .M. Devlin and Francis H. Witham 1986. *Plant Physiology*. 4th Edn. CBS Publishers and Distributors New Delhi.
9. Singh,S.S.2011.*Soil Fertility andNutrient Management*.3rd Edn. Kalyani Publishers.New Delhi
10. Tisdale,S.L., Nelson,W.L.,Beaton, J.D. and Havlin,J.L. 1995. *Soil Fertility and Fertilisers.* 5th Edn. Macmillan publishing company, USA.
11. *Fundamentals of Soil Science*. Published by Indian Society of Soil Science, IARI New Delhi, *2002*

4. Ssac.2104. Environmental Studies and Disaster Management (1+1) (SS&AC & Agrl. Meteorology)

Theory

Environmental studies: Multidisciplinary nature, 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, water logging, 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-sports 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. 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 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. -Collection, processing and storage of effluent samples; Physical, chemical and biological analysis of soil and water samples : Determination of Bio-Chemical oxygen demand (BOD) in effluent sample; Determination of chemical oxygen demand (COD) in effluent sample; Estimation of dissolved oxygen in effluent samples; Determination of total dissolved solids (TDS) in effluent samples; Estimation of species abundance of plants; Estimation of nitrate and heavy metals in ground water; Analysis of temporary and total hardness of water sample by titration; Estimation of pesticide contamination in Agro-Ecosystem; Crop adaptation to environmental variables, soils conditions; Visit to a local polluted site. Observations and remedial measures. Visit to Social Service Organization / Environmental Education Centers.

Lecture schedule

1. Environmental studies: Multidisciplinary nature, definition, scope and importance-type and segments of environment.
2. Natural Resources: Renewable and non-renewable resources- Forest, water, food, mineral, energy and land resources. Forest resources: Use and over-exploitation, deforestation.Water resources: Use and over-utilization of surface and ground water,
3. Mineral resources: Use and exploitation. Food resources: World food problems. Energy resources: renewable and non-renewable energy sources, use of alternate energy sources.
4. Land resources: land degradation, soil erosion and desertification. • Role of individuals in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.
5. Ecosystems: Definition, concept, structure and functions,types,energy flow -producers, consumers and decomposers,
6. Ecological succession, food chains, food webs and ecological pyramids. Characteristic features, structure and functions of forest ,grassland ,desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
7. Biodiversity – definition and classification .Biogeographical classification of India -Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
8 Biodiversity at global, national and local levels.Hot spots of biodiversity.Threats to biodiversity: habital loss, poaching of wildlife, man -wildlife conflicts - Endangered and endemic species of India . Conservation of biodiversity: In-situ and Ex-situ conservation.
9. Environmental Pollution: definition, cause, effects and control measures . Air pollution -. Water pollution - Soil pollution - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards.

   Mid Term Examination
10. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.
11. Social Issues and the Environment: From Unsustainable to Sustainable development,

Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies.

12. 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.
13. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme.
14. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.
15. Disasters -Natural Disasters- nature, types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.
16. 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.
17. Disaster Management- Effect to mitigatete natural disaster at national and global levels. International strategy for disaster reduction.
18. 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 schedule

1. Visit to a local polluted site -Collection, processing and storage of polluted soil and water samples.
2. Determination of pH and electrical conductivity of polluted soil and water samples.
3. Extraction and estimation of toxic/ heavy metals in the soil and water samples collected from the polluted area .
4. Determination of physical properties of polluted water sample-colour ,temperature, odour, turbidity etc.
5. Determination of Biochemical Oxygen Demand (BOD) in effluent / polluted samples.
6. Determination of Chemical Oxygen Demand (COD) in effluent / polluted samples.
7. Determination of dissolved oxygen in effluent / polluted samples.
8. Determination of total dissolved solids (TDS) and total suspended solids(TSS) in effluent samples.
9. Estimation of nitrate and chlorine content in ground water .
10. Determination of carbonates and bicarbonates in water sample.
11. Determination of total hardness of water samples by titrimetry.
12. Pesticide residue analysis - collection of samples for monitoring of pesticides and extraction and clean-up proedures of pesticide residues.
13. Estimation of pesticide residues by gas-liquid chromatography.
14. Identification of plant species in an ecosystem –biodiversity assessment-pollution indicators.
15. Field visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain etc.
16. Pollution case studies- Visit to a local polluted site, observations and remedial measures.
17. Visit to Social Service Organization / Environmental Education Centers, study of simple ecosystems-pond, river, hill slopes, etc.- study of common plants, insects, birds etc.
18. Practical Examination

Suggested Readings

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. Hodges, L.1973. *Environmental Pollution*. 2nd Edn. Holt,, Rinehart and Winston, USA

4. Gupta, A.K. 2007. Methods in Environmental Analysis Water, Soil and Air. 2nd Edn. Published by AGROBIOS(India) Jodpur
5. Katyal, K. and Satake, M. 1990. *Environmental Pollution*. 2nd Edn. Anmol Publishers, New Delhi
6. Larcher, W. 1980. *Physiological Plant Ecology*. Springer- Verlag, New York
7. Loomis, R.S and Corner, D.J. 1992. *Crop Ecology, Productivity and Management in Agricultural Systems*. Cambridge University Press
8. Pandey, S.N and Misra, S.P. 2011 *Environment and Ecology*. Ane Books Pvt. Ltd. India
9. Purohit,S.S. 2006. *Environmental Pollution Causes, Effects and Control*. Published by AGROBIOS (India), Jodpur

5. Ssac 2105 - Principles of Organic Farming (1+1) (SS&AC and Agronomy)

Theory

Organic agriculture-history-concepts- philosophy- objectives, opportunities and priorities- criticisms; Organic farming and food security- Current status of organic farming in India and Kerala; Tools and practices of organic farming- planned crop rotation, green manures, manuring and composting, multiple cropping, intercropping in relation to maintenance of soil productivity, Biological pest control, biological agents and pheromones, Control of weeds, diseases and insect pests- sanitation, tillage and cultivation, cover cropping, mulching, fire, biorational pesticides, foliar fertilization, buffers and barriers- shelter zones; Impact of organic farming on soil and crop quality- Organic farming initiatives in India and Kerala- National Programme for Organic Production (NPOP) – Operational structure of NPOP-Accreditation agencies- Certification Agencies – National Standards for Organic Product (NSOP)-inspection and certification procedures- Record keeping-Socio-economic impacts -Marketing and export potential

Practical

Preparation of enriched farm yard manure; Bangalore method of composting- Coir pith composting- Preparation of vermicompost; Familiarization with biofertilizers- Raising green manure crops- Plant protection through bio-agents, bio pesticides and pheromones, Organic cultivation of vegetables-Visit to bio control labs- Study of profitable utilization of agricultural wastes; Visit to poultry and dairy units to study resource allocation, utilization and economics; Visit to organic farms to study various components and utilization;

Lecture schedule

1. Organic agriculture-history- concepts- philosophy- objectives; opportunities and priorities-constraints
2. Implications of organic farming on food security-current status in India and Kerala
3. Principles of organic farming- biodiversity, diversification and integration of enterprises, sustainability, natural plant nutrition, natural pest management
4-5. Tools and practices of organic farming: planned crop rotation, green manures and cover crops, manuring and composting, multiple cropping, intercropping in relation to maintenance of soil productivity
6. Biological pest control, biological agents and pheromones
7-10. Control of weeds, diseases and insect pests- Sanitation, tillage and cultivation, mulching, ire, bio rational pesticides and foliar fertilization-buffers and barriers- shelter zones

Mid Term Examination

11. Impact of organic farming practices on soil and crop quality
12. Organic farming initiatives in India and Kerala- National Programme for Organic Production (NPOP)- Operational structure of NPOP
13-15. Accreditation agencies- Certification Agencies

16-17. National Standards for Organic Products (NSOP)-inspection and certification Procedures- record keeping
18. Socio-economic impacts- Marketing and export potential of organic products

Practical schedule

1. Nutrient composition of organic manures
2. Preparation of enriched farm yard manure
3-5. Organic raising of vegetable crops
6. Bangalore method of composting
7. Coir pith composting
8. Preparation of vermicompost
9. Familiarisation and field application of biofertilizers.
10. Identification and raising green manure crops
11-13. Preparation of biopesticides
14. Visit to a bio control laboratory
15. Organic recycling and visit to urban waste recycling unit;
16. Visit to poultry and dairy units to study resource allocation, utilization and economics
17. Visit to organic farms to study various components and utilization
18. Practical Examination

Suggested Readings

1. Ananthakrishnan, T.N. (ed.) 1992. *Emerging Trends in Biological Control of Phytophagous insects.*Oxford & IBH, New Delhi.
2. Balasubramanian, R., Balakrishnan, K and Shivasubramanian.2013.*Principles and Practices of Organic Farming.*Satish Serial Publishing House,New Delhi
3. Chhonkar, P.K. and Dwivedi, B.S. 2004. *Organic farming and its implications on India's food security.Fertil. News* 49(11): 15-18,21-28,31&38
4. Gaur, A.C. 1982.*A Manual of Rural Composting*. FAO/UNDP Regional Project Document, FAO, Rome.
5. Gehlot, Dushant.2010. Organic farming : Components and Management, AgroBios, Jodhpur
6. Joshi, M.2012. *New vistas of organic farming* Scientific Publishers, New Delhi
7. KAU [Kerala Agricultural University]. 2009. *Package of Practices Recommendations (Adhoc) for organic farming: Crops*, Kerala Agricultural University, Thrissur 200p.
8. Lampin, N. 1990.*Organic Farming.*Farming Press Books, Ipswitch, U.K.
9. Palaniappan, S.P and Annadurai, K. 2014. *Organic Farming- Theory and Practice*, Scientific Pub., Jodhpur.
10. Singh, S.P. (ed.) 1994. *Technology for Production of Natural Enemies*, Project Directorate of Biological Control, Bangalore.
11. Thapa,U and Tripathy,P. 2010. *Organic Farming in India- Problems and Prospects*. Agrotech Publishing Academy, Udaipur
12. Veeresh, G.K., Shivashankar, K. and Singlachar, M.A. 1997. *Organic Farming and Sustainable Agriculture*, Association for Promotion of Organic Farming, Bangalore.
13. Woomer, P.L. and Swift, M.J. 1994. *The Biological Management of Tropical Soil Fertility,*.S.B.F. &

6. Ssac 2206 Problem soils and their management (2+0)

Theory

Soil resources of India; Problem soils – definition –classification - area and distribution;

Acid soils : characteristics, problems and management/reclamation; Salt affected soils: characteristics, problems and management/reclamation; Arid soils : characteristics, problems and management ; Submerged soils : characteristics, problems and management Acid sulphate soils : genesis, classification, characteristics and reclamation/management; Eroded soils : characteristics, problems, soil conservation technique and management; highly and slowly permeable soils (sandy and clayey soils): characteristics, problems and management ;– Degraded soils: Mine soils, Impact of mining and quarrying on environment and reclamation measures, Eroded soils; contaminated soils: sources of contamination and management; extent and type, characteristics, problems and management; waste lands and their management; Problem soils of Kerala; formation characteristics and management; Problem soils of India: characteristics and management.

Lecture schedule

1	Soil resources of India; Problem soils – definition –classification - area and distribution
2-5	Acid soils, sources of acidity, types of acidity, classification, characteristics, problems, LR and management/reclamation
6-9	Salt affected soils: classification, criteria for characterization characteristics, problems GR, leaching requirement, Quality of irrigation water, effect of water quality on soils and plants, management/reclamation
10	Arid soils : genesis, characteristics, problems – (thermal regime) and management
11-14	Submerged soils : characteristics, electrochemical and nutritional changes during submergence, sequential reduction, problems and management;
15-16	Acid sulphate soils : genesis , classification, characteristics and reclamation/management
17-19	Eroded soils : characteristics, reasons, problems, quantification USLE, soil conservation techniques, agronomic engineering and management of eroded soils
	Mid Term Examination
20-21	Highly and slowly permeable soils (sandy and clayey soils): characteristics, problems and management
22-23	Degraded soils: Mine soils, types, characteristics, problems and management, impact of clay mining, sand mining, quarrying on environmental and reclamation measures
24-27	Contaminated soils: sources of contamination, extent and type problems and remediation techniques including bioremediation
28-29	Waste lands, extent and distribution, and their management
30-31	Problem soils of Kerala; genesis, characteristics and management;
32-33	Problem soils of India: extent and types, characteristics, problems and management;
34-36	Use of GIS techniques for delineation and mapping of problem soils and to evolve suitable land use plans

Suggested Readings

1. Abrol, I.P. and Dhruvanarayana V.V. 1998. *Technologies for Wasteland Development*, ICAR, New Delhi
2. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. 1982. *Saline Alkali Soils of India*, ICAR, New Delhi.
3. Banerjee, A. and Kumar, D.J. 2014. *Alluvial and Red Lateritic Soil Types of West Bengal, India*. Lambert Academic Publishing Co.
4. Biswas,T.D. Naryanswami, G, Goswami, N.R; Sekhon, G.S. and Shastry, T.G. 1991. *Soil Related Constraints in Crop Production.* Tech. Bull. No. 15. Indian Society of Soil Science, New Delhi.
5. Biswas, T.D. and Mukharjee, S.K. 2001. *Text Book of Soil Science*, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
6. Dent, D. 1986. *Acid Sulphate Soils: A Baseline for Research and Development***.** International Institute for Land Reclamation and Improvement/ILRI, Wageningen P. 204

7. Guptha S.K and Guptha I.C. 2014. *Salt Affected Soils : Reclamation and Management.* Scientific Publishers, New Delhi
8. KAU, 1984. *A Glimpse to Problem Soils of Kerala* (ed). P.Padmaja *et al*., Kerala Agricultural University, Vellanikkara
9. ISSS. 2009. *Fundamentals of Soil Science,* Indian Society of Soil Science, New Delhi
10. Varghese, T. and Byju, G. 1993. *Laterite Soil: their Distribution, characteristics, classification and Management* ,STEC, Thiruvananthapuram, Kerala, India

7. Ssac.3107 Geoinformatics, Nanotechnology and Precision Farming (1+1) (SS&AC and Agronomy)

Theory

Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture. Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Remote sensing concepts and application in agriculture; Image processing and interpretation; Global positioning system (GPS), components and its functions; Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs; 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 seed, water, fertilizer, plant protection for scaling-up farm productivity.

Practical

Introduction to GIS software, spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS. Creation of productivity and management zones. Fertilizers recommendations based of VRT and STCR techniques. Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of GPS for agricultural survey. Formulation, characterization and applications of nanoparticles in agriculture. Projects formulation and execution related to precision farming

Lecture schedule

1. Precision agriculture- introduction, scope, concepts and techniques , components and its implications, issues ,role and concerns in Indian agriculture.
2. Geo informatics- definitions and terminology, concepts, techniques and tools ,their use in precision agriculture.
3. Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies.
4. GIS -components of GIS, Spatial data and their management ,Graphic representation of data-Vector /Raster- models-digitization.
5. Data- creation of data- storage of data-geo coding and geo referencing –data file management –input methods and analysis -overlay analysis- GIS data outputs- maps, graphical outputs.
6. Remote sensing- concepts – applications in agriculture images – sensor systems-satellites, types- NOAA satellites, GOES satellites, INSAT,IRS, SEASAT,OCEANSAT-1,IKONOS
7. Digital image processing and interpretation- transformations- DTM, Triangulated irregular network (TIN)-Applications of DTM. Application of modelling in agriculture- crop yield models-simulation models-growth models
8. Global positioning Systems (GPS)- components, functions and applications.
9. Integration of Remote sensing and GIS -need for integration-applications.

Mid Term Examination

10. Soil fertility management- Soil Test crop response (STCR) studies , Crop Simulation Models and their uses for optimization of agricultural inputs.
11. Nanotechnology -introduction– history – terminologies – definitions-– basic principles, concepts, nano scale, nano dimension effects.
12. Nanoparticles, nano materials, nano structures – their properties,
13. Synthesis of nano particles – concepts , up - down and bottom-up approaches, physical methods – attrition, pyrolysis ,chemical synthesis – soil gel process .
14. Nano structured materials – fullerenes, nano tubes, nano filters, nano clays, nano balls, bulky balls etc.- properties and synthesis
15. Nano composites – polymers, nano crystals etc. – properties and synthesis
16. Nano technology in Agriculture and allied fields – nano farming , precision farming
17. Nano technology in soil fertility management – nano fertilizers, nano pesticides, soil binders, nano sensors, smart delivery mechanism to targeted site for promoting nutrient availability.
18. Use of nanotechnology in seed, water, fertilizer, plant protection for scaling-up farm productivity.

Practical schedule

1. Introduction to GIS software,
2. Spatial data creation and editing.
3. Introduction to image processing software.
4. Familiarization with different remote sensing equipments and data products
5. Interpretation of aerial photographs and satellite data for mapping of land resources;
6. Visual and digital interpretation of remote sensing images.
7. Generation of spectral profiles of different objects.
8. Supervised and unsupervised classification and acreage estimation.
9. Use of GIS for soil spatial simulation and analysis
10. Multispectral remote sensing for soil mapping.
11. Creation of thematic layers of soil fertility based on GIS.
12. Creation of productivity and management zones using GIS.
13. Fertilizers recommendations based of VRT and STCR techniques.
14. Crop stress (biotic/abiotic) monitoring using geospatial technology.
15. Use of GPS for agricultural survey.
16. Formulation, characterization and applications of nanoparticles in agriculture.
17. Projects formulation and execution related to precision farming,visit to nanotechnology centre.
18. Practical Examination

Suggested Readings

1. Burrough.P.A.1983. *Geographical information systems for natural resource assessment.* Newyork, Oxford University press.
2. Burrough.P.A.1986.*Principles of Geographical information systems for land resource assessment.* Clarendon Press, Oxford.
3. Chrisman.N.R. 1997. *Exploring Geographic information systems*, Johny wiley and sons, Newyork.
4. Curran.P.1989.*Principles of Remote sensing*. Longman ,London

5. Joseph, T. and Morrison, M. 2006. *Nano Technology in Agriculture and Food*. Nanoforoum.org.

6. Kumar, U. 2012. *Hand book of Nano Technology*. Agrobios (India), Jodhpur.

7. Liles land , T.M and Keifer, R.W. 1979 ,1994, 2000. *Remote sensing and image interpretation*., Johny wiley and sons, Newyork.

8. Nag.P and Kudrat.M.1998. *Digital Image processing*. Concept publishing company. New Delhi.

9. Qin Zhang. 2015.*Precision Agriculture Technology for crop farming*.CRC Press.

10. Rattan Lal and Stewart. B.A..2015. *Soil specific farming-Precision Agriculture*.CRC Press.

11. Reddy, A.M.2006.*Text book of Remote sensing and Geographical Information Systems* ,BS Publications. Hyderabad.

12. Star,J. and Estes John.1999. *Geographic Information systems- An introiduction* , Prentice Hall, New Jersey, USA

AGRICULTURAL MICROBIOLOGY

1. Micr 2101 Agricultural Microbiology (2+1)

Theory

History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Protection against infections, Applied areas of Microbiology Metabolism in bacteria: ATP generation, chemoautotrophy, photo autotrophy, 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: microbial spoilage and principles of food preservation. Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases, Biodegradation, Biogas production, Biodegradable plastics, Plant – Microbe interactions.

Practical

General instructions, 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 stabling; 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, Enumeration of bacteria: Enumeration of bacteria by Pour plate method and Spread plate method. Isolation and identification of different biocontrol and biofertilizer organisms.

Lecture schedule

1-2. Introduction to microbial world – history of microbiology – important contributions - spontaneous generation theory – germ theory of diseases -applied areas of microbiology
3. Prokayotic and eukaryotic microorganisms – differences
4-6. Bacterial cell morphology and structure
7. Nutrition and nutritional groups of bacteria
8-9. Metabolism in bacteria - ATP generation – respiration - fermentation
10-11. Bacteriophages – structure and properties of bacterial viruses – lytic and lysogenic cycles – viroids, prions
12-14. Bacterial genetics – gene expression – genetic recombination – transformation, conjugation and transduction
15. Genetic engineering – plasmids, episomes, genetically modified organisms
16. Soil microbiology - microbial groups in soil
17-18. Microbial transformation of C, N, P & S
Mid term examination
19-20. Biological nitrogen fixation
21. Rhizosphere and phyllosphere microflora
22. Microbes in composting
23. Microbiology of water
24. Food microbiology – microbial spoilage – principle of food preservation

25-27. Beneficial microorganisms in agriculture – biofertilizers – bacterial, cyanobacterial and fungal
28-29. Microbial inoculants for management of plant diseases – microbial insecticides
30-31. Biodegradation of pesticides, herbicides and agricultural wastes
32. Biogas production
33. Biodegradable plastics
34-35. Plant microbe interactions – beneficial – symbiotic, associative and non symbiotic
36. Plant microbe interaction – Plant growth promoting rhizobacteria- plant pathogens

Practical schedule

1. Use and care of microscope – focusing
2. Familiarization with instruments, glassware and other materials in a microbiology laboratory
3. Preparation of media – nutrient broth – nutrient agar plates, slant etc
4. Sterilization – different methods of sterilization – sterilization of glasswares – sterilization by filtration
5. Aseptic techniques with nutrient broth tubes
6. Isolation of bacteria by streak plate method
7. Isolation of aerobic spore forming bacteria by enrichment
8. Identification of bacteria – staining techniques – simple staining
9. Differential staining – Gram staining
10. Isolation and identification of *Rhizobium*
11. Isolation and enumeration of *Azospirillum* and *Azotobacter*
12. Isolation and identification of phosphate solubilizing bacteria and estimation of P solubilization
13. Isolation of antagonists from soil by crowded plate assay and antagonistic studies
14. Estimation of AMF colonization in plant roots
15. Mass production of biofertilizers- *Azospirillum/ Rhizobium*
16. Mass production of biocontrol agents-*Trichoderma* and *Pseudomonas fluorescens*
17. Quality analysis of formulated microbial products,enumeration of bacteria by viable plate counts
18. Practical Examination

Suggested Readings

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. Subba Rao , N.S. 1995 .*Soil Microorganisms and Plant Growth* .Oxford & IBH, New Delhi.
6. Tauro, P., Kapoor, K.K. and Yadav, K.S. 1989 . *An Introduction to Microbiology*. Wiley Publications ,New Delhi

PLANT BREEDING AND GENETICS

1. Pbgn 1101 - Fundamentals of Genetics (2+1)

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity, Cell division – mitosis, meiosis, Probability and Chi-square. Dominance relationships, gene interaction. 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 changes in chromosome, Mutation, classification, Methods of inducing mutation & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Epistatic interactions with examples. 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. 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 structure.

Lecture schedule

1-2	Pre and Post Mendelian concepts of heredity, Mendelism
3	Chromosomal theory of inheritance- cell cycle and cell division -mitosis and meiosis
4-6	Dominance relationships and gene interactions with examples
7-8	Multiple alleles and blood group genetics, pleiotropism, penetrance, expressivity and pseudo alleles
9-10	Morphology, number and types of chromosomes- special chromosomes-Karyotype and Ideogram
11-14	Structural and numerical changes in chromosome and their implications Use of haploids, di haploids and doubled haploids in Genetics
15-17	Nature, structure & replication of genetic material
	Mid Term Examination
18-20	Transcription and translation, genetic code, outline of protein synthesis,
21	Gene concept; Gene structure, function and regulation, Lac and Trp operons
22-24	Linkage and its estimation, crossing over mechanisms, chromosome mapping
25-26	Sex determination and sex linkage, sex limited and sex influenced traits
27-30	Mutation - characteristic features, classification, methods of inducing mutations, ClB technique, mutagenic agents and induction of mutation
31-32	Qualitative & quantitative traits, polygenes and continuous variations, multiple factor hypothesis
33- 34	Cytoplasmic inheritance
35- 36	Genetic disorders

Practical schedule

1	Study of microscope
2	Preparation and use of fixatives and stains for light microscopy

3-4 Preparation of micro slides and identification of various stages of mitosis
5-6 Preparation of micro slides and identification of various stages of meiosis
7 Probability and Chi-square analysis
8 Monohybrid ratio and its modifications
9 Dihybrid ratio and its modifications
10 Trihybrid ratio
11-13 Gene interactions – Epistatic genes, Supplementary genes, Duplicate genes and Complementary genes, Additive and Inhibitory genes
14 -15 Determination of linkage- Two point test cross
16 Determination of linkage- Three point test cross
17 Study on sex linked inheritance in Drosophila,study of models on DNA & RNA structures
18. Practical Examination

Suggested Readings

1. Acquaah, G. 2007. *Principles of Plant Genetics & Breeding*. Blackwell Publishing Co., New Delhi
2. Gardner, J., Simmons, M. J. and Snustad, D. P. 2009. Principles of Genetics (8th Ed.). Wiley India Pvt. Ltd., New Delhi.
3. Gupta, P.K. 1999. *Cytogenetics*. Rastogi Publishers, Meerut.
4. Krebs, J. E., Goldstein, E. S. and Kilpatrick, S. T. 2014. *Lewin's Genes.XI* . Jones and Bartlett India Pvt. Ltd., New Delhi.
5. Pierce, B. A. 2014. *Genetics - A conceptual Approach*. W.H. Freeman & Company, California
6. Singh, B.D. 2000. *Fundamentals of Genetics* (6th Ed.). Kalyani Publishers, Ludhiana
7. Singh, P. 1995. *Elements of Genetics*. Kalyani Publishers, Ludhiana.
8. Stansfield, W.D. 1986. *Schaum's Outline of Theory and Problems of Genetics*. Mc Graw-Hill Book Co., Singapore.
9. Strickberger, M.W.1996. *Genetics* (3rd Ed.). Mac Millan Publishing Co., New Delhi.
10. Swanson, C.P., Merz,T. and Young, J. 1975. *Cytogenetics*. Prentice Hall of India Pvt. Ltd., New Delhi.
11. Winchester, A.M.1967. *Genetics* (3rd Ed.). Oxford and IBH Publishing Co., New Delhi.

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2. Pbgn. 1202- Fundamentals of Plant Breeding (2+1)

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, introduction; Centre of origin/diversity, component 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; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Wide hybridization and pre-breeding; 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; 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. Handing of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiment, 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.

Lecture schedule

1. History, concept and role of plant breeding, Achievements & future prospects of plant Breeding
2. Modes of reproduction – Sexual and asexual, Apomixis - classification & Significance
3. Self Incompatibility –types and applications in crop improvement
4. Male sterility –types and utilization in crop improvement
5. Plant genetic resources – conservation and utilization
6. Centers of origin and diversity, Acclimatisation and domestication
7. Systems of mating –Random and non random-Genetic basis and methods of breeding suited to SP & CP plants
8. Introduction as a breeding method
9. Components of variability , heritability and genetic advance

10- 13 Selection – Mass, Pure line and maternal selections – pure line theory

14- 15 Combination breeding – objectives and types - handling of segregating generations

16 -17 Back cross breeding – advantages and methodology – multiline concept

18 Heterosis breeding – features and theories of Heterosis - estimation of heterosis

Mid Term Examination

19 - 21 Exploitation of hybrid vigour, development of inbred lines and their evaluation – inbreeding depression-Types of hybrids - Single cross, three way and double cross hybrids, synthetics and composites

22 Concepts of population genetics and Hardy Weinberg law

23 – 24 Population improvement - different types of recurrent selection schemes

25 Asexually propagated crops – their genetic basis and breeding - Clonal selection

26 – 27 Mutation breeding – types and nature of mutations - Mutagens- physical and chemical mutagens

28 Handling of mutated populations- problems and prospects

29 Breeding for biotic & abiotic stresses

30 -31 Polyploidy breeding-origin and classification polyploids

32 Role of polyploidy in evolution of crop plants - Evolution of bread wheat , cotton, U's triangle

33. Wide hybridization and pre breeding, significance in crop improvement

34 – 35 Recent approaches in crop improvement - DNA markers, marker assisted selection

36 Participatory plant breeding, Plant Breeders and & Farmer's Rights

Practical schedule

1. Plant Breeder's kit, Study of germplasm of various crops

2 -3. Floral biology of self pollinated crops like rice, cowpea etc

4 -5. Floral biology of cross pollinated crops like maize, coconut etc

6 -8. Emasculation & Hybridization techniques in various self and cross pollinated crops

9. Study of male sterility system in crops and consequences of inbreeding
10. Field layout of experiments, Data collection and Maintenance of records and registers
11. Designs used in plant breeding experiments, Analysis of Randomized Block Design
12. Estimation of variability parameters- mean, range variance, SD, SE, genotypic & phenotypic coefficient of variations, Heritability& Genetic Advance
13. Estimation of Heterosis and inbreeding depression
14. Prediction of performance of three way cross & Double cross hybrids
15 Problems on Hardy Weinberg Law

16. Identification of mode of pollination in a given crop
17 Estimation of extent of natural out- crossing
18. Practical Examination

Suggested Readings

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.

3. Pbgn. 2103 Crop improvement I (1+1)

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; vegetables; Plant genetic resources, its utilization and conservation Floral biology, 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); Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops. Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeonpea, etc. Ideotype concept and climate resilient crop varieties for future.

Practical

Emasculation and hybridization techniques in different crop species; viz., Rice, Maize, Sorghum, Pearl Millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Seasame, Caster, Cotton, Cowpea, Pearl millet. 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 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.

Lecture schedule

1 Plant genetic resources – its utilistion and conservation
2 Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops

3 Breeding objectives and conventional as well as modern approaches for development of varieties and hybrids for yield,adaptability, stability and quality (physical, chemical and Nutritional)

4-5 Centers of origin, distribution of species, wild relatives, breeding methods and hybrid seed production technology in rice,.

6-7 Centers of origin, distribution of species, wild relatives and breeding methods in wheat, sorghum and bajra

8 Centers of origin, distribution of species, wild relatives and breeding methods and techniques of maize

9-10 Centers of origin, distribution of species, wild relatives and breeding methods in pulses- cow pea, pigeon pea, mung bean, black gram

Mid Term Examination

11-13 Centers of origin, distribution of species, wild relatives and breeding methods in oilseeds - coconut, groundnut, sesame, caster, soybean, sunflower,

14 - 15 Centers of origin, distribution of species, wild relatives and breeding methods in vegetables – tomato, bhindi, chilli, brinjal,

16- 17 Centers of origin, distribution of species, wild relatives and breeding methods in vegetables - cucurbits.

18 Ideotype concept and climate resilient crop varieties for future.

Practical schedule

1. Floral biology, emasculation, hybridization techniques and parentage of released varieties/ hybrids in rice
2 Floral biology, emasculation, hybridization techniques and parentage of released varieties in sorghum
3 Floral biology, emasculation, hybridization techniques and parentage of released varieties/ hybrids in maize
4 Floral biology, emasculation, hybridization techniques and parentage of released varieties/ hybrids in bajra
5 Floral biology, emasculation, hybridization techniques and parentage of released varieties in redgram, cowpea
6 Floral biology, emasculation, hybridization techniques and parentage of released varieties in green gram/black gram
7 Floral biology, emasculation, hybridization techniques and parentage of released varieties in ground nut
8 Floral biology, emasculation, hybridization techniques and parentage of released varieties/ hybrids in coconut / sesame
9 - 10 Floral biology, emasculation, hybridization techniques and parentage of released varieties in cucurbits
11-12 Floral biology, emasculation, hybridization techniques and parentage of released varieties in chilli/ brinjal/ tomato
13 Floral biology, emasculation, hybridization techniques and parentage of released varieties/ hybrids in Bhindi / cotton
14 Study of quality characters and donor parents for different characters
15 Estimation of heritability, heterosis and inbreeding depression
16 Lay out of field experiments and study of field techniques for seed production
17. Visit to seed production plots and AICRP centers
18. Practical Examination

Suggested Readings

1. Banga, S.S. and Banga, S.K.1998. *Hybrid Cultivar Development*. Narosa Publishing House Pvt. Ltd., New Delhi.

2. Chahal, G.S. and Gosal S.S. 2002. *Principles and procedures of Plant Breeding*. Narosa Publishing House Pvt. Ltd., New Delhi.
3. Chopra, V. L. and Prakash, S. 2002 *Evolution and Adaptation of Cereal Crops*. Oxford University Press
4. Fehar, W.R.1987. *Principles of Cultivar Development* (Vol. I & II). Macmillan publishing Co., New York.
5. Hancock, J.F. 1989. *Plant Evolution and the Origin of Crop Species*. Prentice Hall, Englewood Cliffs, New Jersey.
6. Ram, H. H. and Singh, H.G. 1986. *Crop Breeding and Genetics*. Kalyani Publishers, Ludhiana.
7. Singh, B.D. 2002. *Plant Breeding Principles and Methods*. Kalyani Publishers, Ludhiana.
8. Simmonds, N.W. and Smartt, J. 2014. *Principles of Crop Improvement*. Wiley India Pvt. Ltd., New Delhi.
9. Stoskopf, N. C., Dwight Tomes, T. and Christie, B.R. 2006. Plant Breeding Theory and Practice. Scientific Publishers (India), Jodhpur.

4. Pbgn. 2204 Crop improvement II (1+1)

Theory

Centers of origin, distribution of species, wild relatives in different cash crops; horticultural crops; fodder crops and fruit crops. Plant genetic resources, its utilization and conservation; Floral biology, 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); Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops. Hybrid seed production technology of crops. Ideotype concept and climate resilient crop varieties for future.

Practical

Emasculation and hybridization techniques in different crop species namely sugarcane. 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 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.

Lecture schedule

1 Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops
2 Genetics of qualitative and quantitative characters
3 Breeding objectives and conventional and modern approaches for development of varieties and hybrids for yield, adaptability, stability and quality (physical, chemical and Nutritional)
4-5 Centers of origin, distribution of species, wild relatives, breeding methods and hybrid seed production technology in sugar cane.
6 Centers of origin, distribution of species, wild relatives and breeding methods in tapioca, rubber
7 Centers of origin, distribution of species, wild relatives and breeding methods and techniques of cocoa
8-9 Centers of origin, distribution of species, wild relatives and breeding methods in pepper

Mid Term Examination

10-11 Centers of origin, distribution of species, wild relatives and breeding methods in other spices like cardamom

12 -13 Centers of origin, distribution of species, wild relatives and breeding methods in mango, cashew, banana

14-15 Centers of origin, distribution of species, wild relatives and breeding methods in ornamentals like orchids, anthurium etc.

16 Centers of origin, distribution of species, wild relatives and breeding methods in fodder crops

17 Centers of origin, distribution of species, wild relatives and breeding methods in important medicinal plants

18 Ideotype concept and climate resilient crop varieties for future.

Practical schedule

1. Floral biology, emasculation, hybridization techniques and parentage of released varieties/ hybrids sugarcane

2 Floral biology, emasculation, hybridization techniques and parentage of released varieties in rubber

3 Floral biology, emasculation, hybridization techniques and parentage of released varieties in cotton

4 Floral biology, emasculation, hybridization techniques and parentage of released varieties in cocoa

5 Floral biology, emasculation, hybridization techniques and parentage of released varieties in pepper

6 Floral biology, emasculation, hybridization techniques and parentage of released varieties in mango

7 Floral biology, emasculation, hybridization techniques and parentage of released varieties in cashew

8 Floral biology, emasculation, hybridization techniques and parentage of released varieties in banana

9 Floral biology, emasculation, hybridization techniques and parentage of released varieties in tapioca and sweet potato

10-11 Floral biology, emasculation, hybridization techniques and parentage of released varieties in spices like cardamom

12-13 Floral biology, emasculation, hybridization techniques and parentage of released varieties in ornamentals – anthurium and orchids

14 Floral biology, emasculation, hybridization techniques and parentage of released varieties in fodder crops

15 Estimation of Heterosis and Inbreeding Depression

16 Lay out of field experiments and study of field techniques for seed production

17 Visit to seed production plots and visit to AICRP centers

18 Practical Examination

Suggested Readings

1. Abraham, A. and Valsala, D. 1981. *Introduction to Orchids with illustration and descriptions of 150 South Indian Orchids.* TBGRI, Thiruvananthapuram
2. Banga, S.S. and Banga, S.K. 1998. *Hybrid Cultivar Development*. Narosa Publishing House Pvt. Ltd., New Delhi.
3. Chahal, G.S. and Gosal S.S. 2002. *Principles and procedures of Plant Breeding*. Narosa Publishing House Pvt. Ltd., New Delhi.
4. Fehar, W.R.1987. *Principles of Cultivar Development* (Vol. I & II). Macmillan publishing Co., New York.

5. Hancock, J.F. 1989. *Plant Evolution and the Origin of Crop Species*. Prentice Hall, Englewood Cliffs, New Jersey.
6. Mercy, S. T. and Dale, B. 1997. *Orchids*. St Joseph's press, Thruvananthapuram.
7. Ram, H. H. and Singh, H.G. 1986. *Crop Breeding and Genetics*. Kalyani Publishers, Ludhiana.
8. Singh, B.D. 2002. *Plant Breeding Principles and Methods*. Kalyani Publishers, Ludhiana.
9. Simmonds, N.W. and Smartt, J. 2014. *Principles of Crop Improvement*. Wiley India Pvt. Ltd., New Delhi.
10. Stoskopf, N. C., Tomes, T. D. and Christie, B.R. 2006. *Plant Breeding- Theory and Practice.* Scientific Publishers (India), Jodhpur.

5. Pbgn. 3205 Intellectual Property Rights (1+0)

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.

Lecture schedule

1	Introduction and meaning of intellectual property
2-3	Introduction to GATT, WTO, TRIPs and WIPO
4	Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc
5 -8	Types of Intellectual Property and legislations covering IPR in India - Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets
9	Patent opposition and revocation, infringement
	Mid Term Examination
10	Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database
11 -12	Origin, history and introduction to UPOV, Protection of plant varieties under UPOV and PPV&FR Act of India
13	Registration of plant varieties under PPV&FR Act 2001
14	Plant breeders rights, researcher and farmers rights
15	Traditional knowledge-meaning and rights of TK holders
16	Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA).
17 -18	Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing

Suggested Readings

1. Acharya, N. K. 2014. *Text Book of Intellectual Property Rights*. Asia Law House, Hyderabad.
2. Adukia, R.S. 2013. *Handbook on Intellectual Property Rights in India*. Jain Book Depot. New Delhi.

3. Catherine, J. 2007**.** *Intellectual property : patents, trademarks, copyrights, trade secrets.* Entrepreneur Press, Holland.
4. Elsy, C. R., Thomas,J. K. and Mohandas, H. 2006. *Primer on IPR in Agriculture*. Kerala Agricultural University, Vellanikkara.
5. Elsy, C. R., Joseph, J. and Thomas,J. K. 2014. *Protection and Management of IPR in Agriculture*. Kerala Agricultural University, Vellanikkara.
6. GOI. 2001 *The Protection of Plant varieties and Farmers Rights*. The Gazette of India 2(1)

   Ministry of Law, Justice and Company Affairs, GOI, New Delhi.
7. GOI. 2003. *The Biological Diversity Act, 2002*. The Gazette of India II (1) Ministry of Law, GOI, New Delhi.
8. Karki, M. M. S. 2009. *Intellectual Property Rights: Basic Concepts*. Atlantic Publishers, Mumbai.
9. Rosedar S.R.A. 2014. *Intellectual Property Rights*(1st Ed.) LexisNexis.

Important Websites

www.ipindia.nic.in – CGPDT, India

www.patentoffice.nic.in – Patent office, India

http://copyright.gov.in/ - Copyright Office, India

www.plantauthority.gov.in – Plant Varieties and Farmers' Rights Authority, India

http://nbaindia.org/ - National Biodiversity Authority

www.nipo.in – The Indian IPR Foundation

www.wipo.int – World Intellectual Property Organisation

http://www.wto.org – World Trade Organisation

SEED SCIENCE TECHNOLOGY

1. Sdtec 3201 Principles of Seed Technology (2+1)

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.

Lecture schedule

1. Seed and seed technology: introduction, definition, its importance in increasing agricultural production. Difference between seed and grain.
2. Concept of seed quality. Deterioration causes of crop varieties and their control. Maintenance of genetic purity during seed production.
3. Genetic and agronomic principles of seed production.
4. Different classes of seed and truthfully labeled seed.
5. Seed certification, phases of certification.
6. Procedure for seed certification, field inspection.

7 & 8. Seed production of important cereals (Rice, wheat and maize)

9 &10. Seed production of important pulses (Cowpea, mung, urd, pigeonpea, field bean and soybean)

11&12. Seed production of important oilseeds (Sesame, coconut, sunflower, groundnut)

13. Seed production of important fodder crops (Guinea grass, napier grass and lucern)

14&15 Seed production of important vegetables (Bhindi, tomato, brinjal, chillies and cucurbitaceous vegetables)
16. Seed Act and Seed Act enforcement. Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency, Central and State Seed Testing Laboratories
17. Duty and powers of seed inspector, offences and penalties.
18. Seeds Control Order 1983 and Seed Bill 2004 and other issues related to seed quality regulation

Mid Term Examination

19. Varietal Identification through molecular tests.
20. Varietal Identification through Grow out tests
21. Varietal Identification through biochemical tests.
22. Synthetic seeds and terminator gene technology. Detection of genetically modified crops
23. Transgene contamination in non-GM crops, GM crops and organic seed production.
24. Physiological and harvestable maturity.
25. Seed dormancy- internal and external factors affecting dormancy in seeds.
26. Seed processing and their steps. Seed pelleting
27. Seed drying
28. Seed treatment, its importance, methods of application
29. Seed packing, Seed sampling and testing.
30. Seed storage: general principles, stages and factors affecting seed longevity during storage.
31. Measures for pest and disease control during storage.
32. Seed marketing: structure and organization, sales generation activities.
33. Dockage. Factors affecting seed marketing, Role of WTO and OECD in seed marketing.
34. Private and public sectors and their production and marketing strategies.
35. Participatory seed production
36. Seed village concept

Practical schedule

1. Varietal identification through seed structure and morphology
2. Varietal identification through physical characteristics of seed
3. Varietal identification through biochemical tests
4. Germination test in field and horticultural crops
5. Quick viability test of field and horticultural crops
6. Seedling vigour test.
7. Seed sampling principles and procedures
8. Physical purity analysis of field and horticultural crops
9. Genetic purity test: Grow out test and electrophoresis
10. Roguing, field inspection and preparation of field inspection report
11. Seed production in major cereals
12. Seed production in major pulses
13. Seed production in major oilseeds

14-15. Seed production in vegetable crops

16. Visit to seed testing laboratories, farms
17. Visit to seed processing plant.
18. Practical Examination

Suggested Reading

1. Agrawal, P.K.and Dadlani, M. 1995. *Techniques in seed science and technology*. South Asian Publishers, New Delhi.

2. Agrawal, R.L.1996. *Seed Technology*. Oxford & IBH Publication Co., New Delhi.

3. Basra, A.S. 2002. *Heterosis and Hybrid Seed Production in Agronomic Crops*. CBS Publishors and Distributors, New Delhi.

4. Dahiya, B.S.; Rai, K.N. 199. *Seed Technology*.Kalyani Publishers, Ludhiana

5. George, R.A.T. 2009. *Vegetable Seed Production (Ed. 3).* CABI, Wallingford, UK.

6. Khare and Bhale , 2014. *Seed Technology*, Scientific Publishers, New Delhi.

7. Stoskopf,N.C., Tomes, D.T. and Christie, B.R. 2006. *Plant Breeding Theory and Practice*. Scientific Publishers (India), Jodhpur.

8. Nema, N.P. 1999. *Principles of Seed Certification and Testing.* Allied Publishers Pvt. Ltd., New Delhi.

9. Renugadevi, J., Srimathi, P. Ranganayaki, R.R and Manonmani, V. 2012. *A handbook of Seed Testing*. Agribios (India).

10. Roy, B., Basu, A.K. and Mandal, A.B. 2013. *Breeding Biotechnology and Seed Production of Field Crop*s. New India Publishing Agency, New Delhi.

11. Sharma, J.P. 2011. Qua*lity Seed Production of Vegetable Crops Technological Interventions, Volume 2: Crop Specific Aspect*. Kalyani Publishers, Ludhiana.

12. Singh, P. and Asat, I. B.S. 2003. *Seed Production Technology of Vegetables*. Daya Publishing House, New Delhi.

13. Singh, S.P. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publishing Academy, New Delhi.

14. Thompson, J.R.1979. *An introduction of Seed technology* . Leonard Hill, London.

15. Tomar H.P.S. 2014. *Seed Technology*, Aman Publishing House,Meerut

16. Verma, O.P. 2011. *Seed Production Technology of Major Crops*. Daya Publishing House, New Delhi.

HORTICULTURE

1. Hort. 1101. Fundamentals of Horticulture (1+1)

Theory

Horticulture - 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.

Practical

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).

Lecture schedule

1-2 Horticulture - definition, importance, division and classification of horticultural crops. Importance of horticulture in India and Kerala.

3 Commercial orchards, garden and plantations - selection of site for perennial horticultural crops - climate, soil, socio economic factors.

4 Orchard planning, layout, planting systems - management practices- methods, intercropping, mixed cropping etc.

5 Tree forms and functions - Training and pruning in horticultural crops- principles and methods, techniques of training and pruning, fruit thinning.

6 Phases of growth and development, vegetative reproductive balance. Flowering in plants - bearing habit and its classification- factors associated with flowering and fruit set.

7 Fruit set and development - structure and process concerned with setting. Fruit drop - factors affecting and control measures - unfruitfulness- internal and external factors.

8 Seedlessness in horticultural crops; significance and induction.

9 Bioregulators- Natural and synthetic regulators - Role of bioregulators in horticultural crops - preparation and methods of application.

Mid Term Examination

10 Plant propagation-definition and basic concepts- types of propagation- advantages and disadvantages, media, containers, potting, repotting pre-planting treatments.

11 Propagation by seed - seed germination - dormancy and presowing treatments of seeds, seed viability and quality seed testing.

12 Asexual propagation - propagation by apomictic embryos, bud sports, chimeras. Plant modifications suitable for vegetative method of propagation - propagation by cuttings, t ypes of cuttings, factors affecting rooting of cuttings.

13 Propagation by layering - advantages, disadvantages - types of layering.

14 Propagation by grafting - advantages and disadvantages - methods of grafting - development of graft unions, separation and after care. Stock-scion relationship - Graft incompatibility - factors affecting incompatibility.

15 Propagation by budding, advantages and disadvantages, methods of budding - A comparative study between grafting and budding.

16 Micropropagation of horticultural plants – definition, principles, methods – advantages and disadvantages - field of application in horticultural crops.

17 Plant propagating structures-.greenhouse, glasshouse, hot bed, cold frame, lath house, net house, mist chamber, classification of nursery plants.

18 Nursery - site selection, layout - components of a nursery – production unit, sales unit, display area, management and maintenance, propagation unit - close planted progeny orchards.

Practical schedule

1. Familiarization with horticultural crops- fruits, vegetables, ornamental plants, plantation crops, spices, medicinal and aromatic plants
2. Planting systems and layout of perennial horticultural crops
3. Planting and aftercare of perennial horticultural crops
4. Tools and implements used in horticulture
5. Training and pruning of horticultural plants
6. Bearing habits of perennial horticultural crops
7. Growth regulators in horticulture
8. Propagation of plants through seeds, protray seedling production
9. Potting and repotting and familiarization with media
10. Propagation of plants through specialized structures
11. Propagation of plants through cutting
12. Propagation of plants through layering
13. Propagation of plants through grafting
14. Propagation of plants through budding
15. Familiarization with components of nurseries– handling, display and sales of plants – cultural practices . Registers to be maintained in a commercial nursery.
16. Studies on preparation of designs and estimates for establishment of plant propagation unit, plant growing structures and tissue culture unit.

17. Visit to different types of nurseries.
18. Practical Examination

Suggested Readings

1. Bose, T.K., Mitra, S.K. and Sadhu, K. 1986. *Propagation of Tropical and Subtropical Horticultural rops*. Naya Prokash, Calcutta.
2. Christepher, E.P. 1958. *Introductory Horticulture*. Mc Graw Hill, New Delhi.
3. Denixon, R.I. 1979. *Principles of Horticulture*. Mac Millan, New York.
4. Edmond, J.B., Sen, T.D., Andrews, T.S and Halfacre, R.G. 1977. *Fundamentals of Horticulture.* Tata Mc Graw Hill, New Delhi.
5. Halfacre, R.G. and Barden, JA. 1979. *Horticulture.* Mc Graw Hill, New Delhi.
6. Hartmann, HT. and Kester, D.E.1986. *Plant propagation - Principles and practices*. Prentice-Hall, New Delhi.
7. Janick, J. 1963. *Horticultural Science*. W.H. Freeman, Sanfrancisco.
8. Singh, J. 2002. *Basic Horticulture*, Kalyani Publishers.
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10. Leopold, A.C. and Kriedeman, P.E. 1975. *Plant Growth and Development.* Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
11. Peter, K. V. *Basics of Horticulture*. New India Publishing Agency, New Delhi.
12. Sheela, V.L. 2011. *Horticulture*. MJP Publishers, Chennai.
13. Thorpe, T.A. 1981. *Plant Tissue Culture: Methods and Application in Agriculture.* Academic Press, New York.

2. Hort.2102 Production Technology for Plantation crops -2+1

Theory

Plantation crops- introduction-importance- area, production, problems and prospects-origin, distribution- botany, varieties- climate, soil, site selection-propagation, production of quality planting materials and hybrids, nursery management-layout, planting, aftercare-irrigation, manuring -stage of harvest, harvesting, yield, on farm processing and uses of coconut, arecanut, oil palm, rubber, cashew, tea, coffee and cocoa.

Practical

Morphology, floral biology, propagation and nursery techniques, production of quality planting materials and hybrids, seedling selection, Familiarisation with varieties, Moisture conservation methods in plantation. Layout and planting, manuring, care and management of plantations. Tapping systems in rubber. Training and pruning in tea, coffee and cocoa.

Lecture schedule

1. Coconut: Importance, origin, distribution area and production- botany-
2. Coconut: Varieties-selection of mother palm and production and selection of seedling. commercial production of hybrids- (TxT, TxD, DxT)
3. Coconut: Climate and soil-site selection-layout and planting,
4. Coconut: Care and management of young and adult palms- manuring, irrigation, moisture conservation
5. Coconut: Intercropping- coconut based cropping system, harvesting, yield- Tapping.
6. Coconut: Problems and prospects of cultivation
7. Arecanut: Importance-origin-distribution-area, production botany and varieties,
8. Arecanut: Climate and soil- mother palm selection-nursery technique- selection of seedlings.

9. Arecanut: Site selection-land preparation-layout and planting-management of palms-arecanut based cropping system-harvesting-yield.
10. Arecanut: Problems and prospects of cultivation
11. Oil palm: Importance- origin-distribution-area-production-botany and varieties.
12. Oil palm: Seed germination and other nursery techniques.
13. Oil palm: Climate and soil- site selection- layout-planting, management of palms. Harvesting, and yield.
14. Rubber: Importance-origin- distribution- area, production, botany varieties-clones – primary, secondary, tertiary, other natural rubber yielding plants-.
15. Rubber: Climate and soil- site selection- soil conservation measures-layout and planting-nursery techniques, planting materials
16. Rubber: management of trees before and after commencement of tapping-cover cropping-intercropping- bee keeping
17. Rubber: Tapping - systems of tapping- -plugging mechanism-tapping tools- different methods of tapping –micro tapping, slaughter tapping- controlled upward tapping, ladder tapping- latex stimulation- rain guarding.
18. Rubber: Marketable forms of rubber – PFL, LC, sheet rubber, crumb rubber, block r ubber, TSR – other ancillary products

Mid Term Examination

19. Cashew: Importance-origin-distribution-area-production, constraints in production, future prospects
20. Cashew: Botany and varieties-propagation-nursery technique
21. Cashew: climate and soil-Site selection-layout-planting materials, planting -high density planting-cultural practices-manuring and fertilizer application - intercropping- training and pruning, field problems
22. Cashew: Harvesting, yield, top working – processing -grading and packing
23. Tea: Importance- origin-distribution-area-production-problems and prospects
24. Tea: Botany –Assam and china jats, clones, biclonal and poly clonal progenies - clonal selection propagation - nursery techniques.
25. Tea: Climate and soil, Site selection- land preparation-layout and planting – shade management
26. Tea manuring, training – development of plucking table – methods, pruning- top pruning, fringe/lung pruning, skiffing, rejuvenation.
27. Tea: cultural practices- harvesting – methods – manual, mechanical, yield – black tea, green tea, oolong tea, brick tea.
28. Coffee: Importance-origin and distribution- area, production- problems and prospects
29. Coffee: botany species and varieties- - climate and soil-.
30. Coffee: Nursery techniques layout and planting- establishing contour strip-shade management-nutrition and fertiliser management
31. Coffee: training and pruning- - irrigation, drought management practices, flowering – floral malformations, improving fruit set
32. Coffee: Harvesting- fly picking, main picking, stripping, gleaning, bean abnormalities, yield, field problems, parchment and cherry coffee.
33. Cocoa: Importance-origin -distribution- area- production, botany and varieties
34. Cocoa: Climate and soil-nursery techniques, layout- land preparation, planting
35. Cocoa: Manuring and other management- training and pruning- top working
36. Cocoa: Harvesting and on farm processing and yield.

Practical schedule

1. Coconut : Morphology and floral biology of coconut
2. Coconut : Techniques of selfing and crossing.
3. Coconut : Mother palm and seedling selection-planting.

4. Coconut : Manuring, Husk burial.
5. Arecanut: Morphology and Floral biology, identification of varieties.
6. Arecanut: Sowing- seedling selection- planting, manuring.
7. Oil palm : Morphology and Floral biology- identification of types
8. Rubber : Morphology and floral biology,
9. Rubber : Propagation , planting materials
10. Tapping : Marking for tapping, methods and systems of tapping.
11. Cashew : Botany, Floral biology, identification of varieties
12. Cashew : Propagation techniques – Layering, Grafting, top working.
13. Tea : Morphology and Floral biology - training and pruning.
14. Coffee : Morphology and Floral biology, identification of species and varieties.
15. Coffee : Propagation- training and pruning
16. Cocoa : Morphology and Floral biology- identification of varieties
17. Cocoa : Propagation-seed and vegetative methods- planting.
18. Practical Examination

Each student will maintain 50 sq. m area each of one plantation crop to gain hands-on experience in the above practical aspects

Suggested Readings

1. Balasimha, D. and Rajagopal, V.2004. *Arecanut*, CPCRI, Kasagod, Kerala.
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11. Purseglove. 1978. *Tropical Crops. Monocots (Vol I & II combined)*
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16. Wrigley,G. 1988.*Coffee*. Tropical agriculture Series, Longman, London.

3. Hort. 2203 Production Technology for Spices, Medicinal and aromatic plants (2+1)

Theory

Importance of Spices with respect to Kerala and India. – History – Present status- Definition – Classification with examples, Scope and importance of organic spices and GAP in spices. Origin – Distribution – area, production – Botany, varieties, climate, soil – Propagation, nursery management – Site selection, lay out, planting –Crop management - Including manuring, irrigation, shade regulation and other cultural operations - harvesting and yield of the following crops –Black Pepper, Small

Cardamom, Large Cardamom, Ginger, Turmeric, Nutmeg, Clove, Cinnamon, Allspice, Garcinia, Tamarind and Vanilla. Important Seed and Herbal Spices.Introduction – history importance, present status and future prospects – classification – different methods of classification, active principles in medicinal plants – Botany, varieties, production technology, active principles and uses Dioscorea, Solanum, Poppy, Cannabis, Brahmi, Centella – Rauvolfia, Belladonna, Alpinia – Kaempferia, Acorus, Senna- Catharanthus, Digitalis – Plumbago, Neem – Indigofera, Bixa, Caesalpinnia, Aloe, *Piper longum*, Neem, Isabgol, Guggul, Eucalyptus, Aswagandha.History, importance, scope, problems and prospects of aromatic plants – classification of aromatic plants – Production technology of aromatic grasses – Lemongrass, Citronella, Palmarosa, Vetiver – Herbal aromatics – Ocimum, Patchouli, Mint, Geranium – Aromatic flower crops – Jasmine, rose, tube rose – aromatic trees – Sandal wood, Eucalyptus– Minor medicinal and aromatic plants.

Practical

Morphology, floral biology, varieties, nursery techniques, planting in main field, cultural operations and harvesting in pepper, cardamom, ginger, turmeric, tree spices and vanilla – hand pollination in vanilla – identification of varieties of important spices.Identification of medicinal plants, Preparation of herbarium of medicinal and aromatic plants and identification of herbarium specimens. Study of morphology, Propagation techniques and nursery management of MAPs. Extraction techniques of medicinal plants. Methods for extraction of aromatic oils.

Lecture schedule

1. Introduction : Spices, condiments and culinary herbs-definition- classification –importance with special reference to Kerala and India. Scope of organic spice culture.

2,3&4. Black pepper: Origin – distribution – area – production – export – botany andvarieties. Climate and soil –propagation and nursery management – site selection,layout and planting of standards of pepper. Crop management including manuring–irrigation – shade regulation – other cultural operations – harvesting and yield.

5. Ginger: Origin – distribution – area, production – botany – varieties – climate & soil Site selection – land preparation – planting – cultural and maurial practices -harvesting – seed rhizome treatment and storage

6. Turmeric: Origin – distribution – area – production – botany – varieties – climate and soil. Site selection – land preparation – planting – cultural and manurial practices harvesting and curing 7,8&9. Small cardamom: Origin – distribution – area – production – botany – varieties. Climate – soil – propagation – nursery techniques – planting. Manuring – weeding –trashing – mulching – irrigation – shade regulation – harvesting.

10. Nutmeg: Origin – distribution – area – production – botany – varieties – propagation – climate and soil – planting and aftercare – harvesting

11. Clove: Origin – distribution – area - production – botany – propagation – climate & soil– planting & aftercare – harvesting

12. Cinnamon: Origin – distribution – area – production – botany – propagation – climate & soil – planting – training & pruning – cultural practices – harvesting

13. Vanilla: Origin – distribution – area – production – botany – propagation – climate and soil – planting of standards and vanilla – crop management, training and pruning – flower induction -hand pollination – harvesting

14. Allspice: origin – distribution – area – production – botany – propagation – climate and soil – planting and aftercare

15. Garcinia: Origin – distribution – botany – varieties – propagation – climate and soil –planting and aftercare – harvesting

16. Tamarind: Origin – distribution – botany – cultivars – propagation – climate and soil - planting and aftercare – harvesting

17. Seed spices: Coriander, Cumin, Fennel, Fenugreek –origin -origin- distribution- climate – harvesting and uses

18. Herbal spices: Marjoram, Savory, Oreganum, Tarragon, Thyme, Sage, Basil, Pepper mint, Parsely, Rosemary –climatic requirements –origin- distribution- stage of harvest- uses-

Mid Term Examination

19. Medicinal plants- Introduction – history importance, present status and future prospects
20. Classification – different methods of classification, major groups of active principles in medicinal plants
21. Botany, varieties, production technology, active principles and uses of - Dioscorea, and Solanum
22. Botany, varieties, production technology, active principles and uses of – Poppy, Cannabis, Brahmi, Centella
23. Botany, varieties, production technology, active principles and uses of – Rauvolfia, *Atropa belladonna*
24. Botany, varieties, production technology, active principles and uses of – Long pepper, Adhatoda, Alpinia
25. Botany, varieties, production technology, active principles and uses of laxative plants – Kaempferia, Acorus, Senna
26. Botany, varieties, production technology, active principles and uses of Catharanthus, Digitalis
27. Botany, varieties, production technology, active principles and uses of Plumbago, Neem
28. Botany, varieties, production technology, active principles and uses of natural dye & cosmetic herbs – Indigofera, Bixa, Caesalpinnia, Aloe vera
29. History, importance, scope, problems and prospects of aromatic plants
30. Classification of aromatic plants – methods of classification - Production technology of aromatic grasses – Lemongrass
31. Production technology of aromatic grasses – Citronella, Palmarosa, Vetiver
32. Production technology of herbal aromatics – Ocimum, Patchouli
33. Production technology of herbal aromatics - Mint, Geranium
34. Production technology of aromatic flower crops – Jasmine, rose, tube rose
35. Production technology of aromatic trees – Sandal wood
36. Minor medicinal and aromatic plants.

Practical schedule

1. Identification of important major and minor spices
2. Pepper – Morphology and Floral biology and identification of varieties
3. Pepper - Propagation
4. Ginger — Morphology and Floral biology and identification of varieties harvesting seed treatment and storage
5. Turmeric — Morphology and Floral biology and identification of varieties, propagation, harvesting seed treatment and storage
6. Cardamom– Morphology and Floral biology and identification of varieties propagation, harvesting
7. Vanilla – Morphology and Floral biology, propagation, training and pruning- hand pollination
8. Nutmeg & Clove – Morphology & Floral biology and identification of varieties
9. Cinnamon & all spice – Morphology & Floral biology and identification of varieties
10. Visit to Spice gardens.
11. Identification of medicinal plants
12. Study of morphological features of major medicinal plants – Rauvolfia, Plumbago, Neem, Long pepper, Adhatoda, Alpinia, Kaempferia,
12. Propagation techniques and nursery management of medicinal plants
13. Extraction techniques of medicinal plants –infusion, decoction, percolation, solvent extraction
14. Identification of aromatic plants and study of morphological features of major aromatic plants – *Cymbopogon* sp., Citronella, Palmarosa, Vetiver – Herbal aromatics – Ocimum, Patchouli, Mint, Geranium , Jasmine, rose, tube rose –Sandal wood, camphor
15. Propagation techniques of aromatic plants
16. Essential oil extraction techniques – Distillation methods

17. Essential oil extraction techniques – Solvent extraction, SCFE
18. Practical Examination

* Students will maintain 50sq.m area of spice to get hands on experience in spices cultivation

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2. Chadha, K.L. and Gupta, R. 1995. *Advances in Horticulture. Vol. II Medicinal & Aromatic plants.* Malhotra Pub. House., New Delhi.
3. Chadha, K.L. and Rethinam, P. (Eds) .1994. *Advances in Horticulture, Vol.9 Plantation and Spice Crops.* Malhotra Publishing House, N. Delhi, India
4. Farooqi, A. A. and Sreeramu, B.S. 2004. *Cultivation of medicinal and aromatic crops.* Universities press (India) Pvt. Ltd., Hyderabad, 647p
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7. Kirthikar, K.R. and Basu, B.D. 1993. *Indian Medicinal Plants*, Vol. 1-4. Lalit Mohan Basu, Allahabad.
8. Kurian, A. and Peter, K.V. 2007. *Medicinal plants.* New India Publishing Agency, New Delhi, 356p
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11. Pruthi, J.S. 1998. *Major spices of India: Crop management and post –harvest technology.* ICAR, New Delhi, 514p
12. Pruthi, J.S. 2001. *Minor Spices and Condiments – Crop Management and Post Harvest Technology*, ICAR New Delhi, 782p
13. Ravindran, P.N (Ed). 2003. *Black Pepper (Piper nigrum.L.)*, CRC Press
14. Ravindran, P.N and Madhusudanan, K.J (Eds). 2003. *Cardamom – The Genus Elettaria*, CRC Press
15. Ravindran, P.N. and Babu, K.N (Eds). 2004. *Ginger - The Genus Zingiber*, CRC Press
16. Ravindran, P.N., Babu, K.N. and Sivaraman, K (Eds). 2002.*Turmeric – The Genus Curcuma*, CRC Press
17. Ravindran,P.N., Babu, K.N. and Shailaja,M (Eds). 2003. *Cinnamon and Cassia- The* ?
18. Sivarajan, V.V. and Balachandran, I. 1994. *Ayurvedic drugs and their plant sources*. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.

4. Hort. 2204. Production Technology for Vegetable crops (2+1)

Theory

Importance and scope of vegetable crops in India with special reference to Kerala; Area, production, productivity of important vegetable crops of Kerala; Nutritive value of Vegetables; Economic importance and scope of various vegetables in Kerala. Classification - botanical; cultural; thermo-classification; classification based on parts used; based on soil acidity; duration. Types of vegetable

farming- kitchen garden; market garden; truck garden; vegetable forcing; vegetable garden for processing; vegetable garden for seed production. Systems of vegetable cultivation- traditional and specialized systems; Low-cost and high-tech-systems, Nutrition garden, Riverbed system, Cultivation under naturally ventilated polyhouse and rainshelter. Cropping systems and patterns- Vegetables in rice based and coconut based cropping systems; mixed cropping, intercropping, relay cropping. Factors affecting vegetable production- temperature, light, moisture, soil, Nutrients. Basic principles in vegetable production- nursery, sowing and transplanting, care and management –Irrigation- surface, sub-surface and spray irrigations – Nutrition - essential nutrients, deficiency symptoms; Methods of application. Growth regulators- important growth regulators and their effects, methods of application. Plant protection special precautions in vegetables-methods of control, rotation, resistant varieties, seed treatments. Vegetable seed production- general principles, breeding system, isolation distance, rouging, cultural operations, seed standards, packing and storage; Seed production in cool season vegetables, post harvest handling- losses; causes and measures to reduce losses; Packing and transport . Marketing of vegetables. Production technology of warm season vegetable- Importance, origin, taxonomy, varieties, cultivation, problems and prospects for Solanaceous crops- tomato, brinjal and chilli- Cucurbits- bitter gourd, snake gourd, cucumber, melons, pumpkins, ash gourd, bottle gourd, ridge gourd, smooth gourd, watermelon, ivy gourd and Other perennials. Leguminous crops- vegetable cow pea, winged bean and other minor crops, okra, Leafy vegetables- amaranthus, basella, chekkurmanis Tropical root vegetables- tapioca, sweet potato, yams and other minor tubers. Production Technology of cool season vegetables- Importance, origin, taxonomy, Varieties, cultivation, problems and prospects of potato, cole crops- cabbage & cauliflower, Root crops- carrot, radish, beet and turnip; bulb crops- onion, garlic and leek; peas and beans, Salad and Leafy vegetables.

Practical

Familiarization of different vegetable crops- through field visits and slide show familiarization of seeds of vegetable crops; preparation of nursery bed, sowing and aftercare- Layout of nutrition garden and preparation of crop calendar; Main field preparation and planting of solanaceous vegetables, cucurbits, amaranthus, legumes and okra; Floral biology and varieties of solanaceous vegetables, cucurbits, amaranthus, legumes and okra; Calculation of fertilizer requirement, application by different methods- Preparation of growth regulator solutions and application; Maturity indices and harvesting of vegetables for vegetable purpose and seed purpose – seed extraction methods, processing and storage; Economics of vegetable cultivation; Visit to the farmer's fields in the vegetable growing areas to study the field problems faced by the farmer.

Lecture schedule

1 Introduction to the course, importance of vegetable growing in India and Kerala in particular, area, production, productivity and distribution, nutritive value of vegetables, economic importance and scope of various vegetables in Kerala; Export of vegetables

2 Classification of vegetables – types of classification and their bases – Botanical, cultural, thermo classification, classification based on parts used, based on soil acidity and duration

3 Factors affecting vegetable production- soil, climate, water, nutrients.

4 Basic principles of vegetable production- Vegetable nursery, seed and seedlings production, transplanting, care and management; Irrigation requirements of vegetables – surface and sub surface irrigation, spray irrigation

5 Nutrition, essential nutrients, deficiency symptoms, methods of application

6 Types of vegetable gardens, nutrition garden, market garden, truck garden, vegetable forcing, vegetable garden for special purpose and processing, veg. gardens for seed production, riverbed system, terrace garden etc

7 Role of growth regulators in vegetable production and methods of application

8 Problems in vegetable production; Plant protection- special precautions in vegetables, methods of control, crop rotation, resistant varieties, seed treatments, etc.

9 General principles of seed production in vegetables- rouging, isolation distance, seed purity, seed standards, – breeder seed, foundation seed, certified seed – packaging and seed storage, moisture and temperature

10 Cropping systems and patterns of vegetable based cropping system, vegetables in rice based and coconut based cropping system, intercropping, mixed cropping, relay cropping, multiple cropping, etc.- Review of the topics covered.

11 Organic farming in vegetables

12 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of Tomato

13 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of Chilli

14 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of Brinjal

15 Importance, origin, taxonomy, varieties, cultivation, problems and prospects of cucurbits

16 Importance, origin, taxonomy, varieties, cultivation, problems and prospects of Bittergourd, snake gourd

18 Importance, origin, taxonomy, varieties, cultivation, problems and prospects of Cucumber, Melons, muskmelons

Mid Term Examination

17 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of Pumpkins, ashgourd,

18 Importance, origin, taxonomy, varieties, cultivation, problems and prospects of Bottle gourd, Ridge gourd, smooth gourd, watermelon, ivy gourd

19 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of perennial and other cucurbits

20 Importance, origin, taxonomy, varieties, cultivation, seed production problems and prospects of legumes and minor legumes

21 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of bhindi

22 Importance, origin, taxonomy, varieties, cultivation, problems and prospects of annual summer leafy vegetables – amaranth, basella, chekkurmanis & others

23 Importance, origin, taxonomy, varieties, cultivation, seed production, problems and prospects of perennial summer vegetables

24 Importance, origin, taxonomy, varieties, cultivation, problems and prospects of cool season vegetables-Cole crops-Cabbage & cauliflower

25 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of Brussels sprout, broccoli

26 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of knolkhol

27 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of cool season root vegetables Carrot & radish

28 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of cool season vegetables-Beet & turnip

29 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of bulb crops-onion

30 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of Bulb Crops- garlic& leek

31 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of Peas & beans

32 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of cool season salad vegetables- lettuce and celery

33 Importance, origin, taxonomy, varieties, cultivation, Seed production problems and prospects of cool season leafy vegetables

34 High tech. systems of vegetable growing- Cultivation under naturally ventilated polyhouse and rainshelter, hydroponics, aeroponics, aquaponics
35 Post harvest losses, phases of loss and measures to reduce the losses, post harvest handling, marketing of vegetables
36 Research organizations working on vegetables and their achievements; Review of topics covered

Practical schedule

1 Familiarization of different vegetable crops- through field visits and slide show
2 Preparation of nursery bed, sowing and aftercare; portray seedling production- solanaceous vegetables
3 Main field preparation and planting of crops - cucurbits
4 Main field preparation and planting of crops – leguminous vegetables and okra and amaranthus
5 Main field preparation and planting of crops – solanaceous vegetables
6 Floral biology and varieties of solanaceous vegetables
7 Floral biology and varieties of cucurbits
8 Floral biology and varieties of legumes
9 Floral biology and varieties of okra and amaranthus
10 Calculation of fertilizer requirement, application by different methods
11 Preparation of growth regulator solutions and application
12 After care and management of crops- cucurbits, okra and legumes
13 After care and management of crops –solanaceous vegetables
14 Layout of nutrition garden and preparation of crop calendar
15 Seed extraction methods, processing and storage
16 Familiarization of seeds of vegetable crops
17. Visit to the farmer's fields in the vegetable growing areas to study the field problems faced by the farmer and to work out the economics of vegetable cultivation
18 Practical Examination

Each student will raise 50 sq. m area of one vegetable crop to gain hands-on experience in the above practical aspects

Suggested Readings

1. Chadha, K. L. 2003. *Handbook of Horticulture*, ICAR, New Delhi.
2. Choudhury, B.1983. Vegetables. National Book Trust, New Delhi.
3. Das, P. C.1993. *Vegetable crops in India*. Kalyani Publishers
4. Gopalakrishnan, T. R. 2007. *Vegetable Crops*. New India Publishing Agency, New Delhi.
5. Hazra, P. and Som, M. G. 1999. *Technology for vegetable Production and Improvement*. Naya Prokash, Calcutta
6. Peter, K. V. 1998. *Genetics and Breeding of vegetables*. ICAR, New Delhi.
7. Peter, K. V. and Hazra, P. 2012. *Handbook of vegetables*. Studium Press LLC, USA
8. Thamburaj, S. and Singh, N. 2005. *Vegetables, tuber crops and spices*. ICAR, New Delhi.

5. Hort 3105 Production technology for Fruit crops (2+1)

Theory

Importance and scope of fruit crop industry in India, with special reference to Kerala. Cultivation practices of important tropical , subtropical and temperate fruit crops with reference to their origin, soil and climatic requirements, botany, important cultivars, plant propagation practices , planting, after care and management in respect of irrigation, nutrition and other cultural operations. Training

and pruning. Nutrient deficiencies of fruit plants and their correction, intercropping, major cultivation problems and their control measures, harvesting, yield, storage and marketing. Application of bioregulators. Post harvest handling technology. Management of major pests and diseases and physiological disorders. Biotechnology and precision farming in fruit crops. Familiarization with minor fruit crops. Fruits covered – banana, mango , pineapple, papaya, sapota, guava, pomegranate. Moraceous and Annonaceous fruits, dates, citrus, grapes, mangosteen, avocado, litchi, apple, pear, peach, plum, strawberry, cherry, minor fruits.

Practical

Introduction to fruit plants – vernacular and botanical names, family, description of vegetative, floral and fruit characters. Nursery operations – production of propagation materials , lifting and shifting of plants, weeding and hoeing; orchard layout and planting; plant propagation methods-sexual and asexual. Seed, seed sowing and germination, planting; Vegetative propagation – budding, grafting, layering . Study of bud take and success of graftage. Irrigation and manuring operations in orchards, training and pruning of fruit plants. Use of bioregulators in fruit set, fruit drop, fruit growth and fruit ripening, harvesting handling, sorting, grading, packing and storage. Visit to tissue culture laboratory, fruit research stations, commercial orchards and nurseries

Lecture schedule

1. Importance of fruit growing - Area, production and productivity– commercial importance - Classification of fruits based on climatic requirements – South Indian fruit zones.
2. Mango – origin, distribution – Area and production – composition and uses – Botany, classification of varieties – climatic and soil requirements.
3. Propagation methods – recent innovations – major pre-planting and post-planting operations – Manurial requirements.
4. Flowering – Factors affecting flowering fruit set and fruit drop – use of growth regulators. Harvest indices , grading, packing, storing and transporting.
5. Major physiological disorders - problems encountered in mango production.
6. Banana – origin and distribution – Area and production – composition and uses – Botany.
7. Genomic classification – taxonomic scoring – Important varieties.
8. Climate and soil requirements – propagation, selection of suckers – plant population in commercial plantations.
9. Manuring, irrigation and other post-planting operations – flowering and factors affecting flowering – harvest indices. Harvesting, grading, packing – Ratooning.
10. Crop improvement – peculiarities and problems of banana cultivation in Kerala.
11. Pineapple – origin and distribution – Area, production – composition and uses – Botany, classification and varieties – general plant description – Flowering and fruit characters.
12. Climate and soil – propagation – systems of planting – population density – Manuring and intercultural operations.
13. Flowering – Manipulation of flowering through bioregulator application – Harvest indices – yield – Ratooning – staggering- physiological disorders – Major pests and diseases.
14. Papaya – Origin and distribution – seed treatment – climate & soil – spacing – planting – Intercultural operations – manuring.
15. Floal biology – Sex expression - Inheritance of sex – Fruit growth and development – Harvesting and yield – papain extraction – Factors affecting papain yield – Important pests and diseases.
16. Guava – origin and distribution – Area and production – composition and uses – Botany – species and varieties – propagation – spacing – planting and aftercare – Manuring – pollarding - Flowering, fruiting and fruit growth – yield – Important pests and diseases
17. Sapota – origin and distribution – Area and production – composition and uses – Botany, species and cultivars – propagation – planting and aftercare – Manuring – flowering, fruit growth and development – harvesting and yield – Important pests and diseases.

18. Grapes – Origin and distribution – Area and production – composition and uses – Botany, species – Climatic and soil requirements – peculiarities of South Indian Viticulture.

Mid Term Examination

19. Varieties – commercial classification – propagation – rootstocks – planting.
20. Training – Objectives, important systems, pruning – types and season.
21. Manuring – Techniques for improving quality of fruit – physiological disorders – harvesting – major pests and diseases.
22. Citrus – Origin and distribution – Area and production – composition and uses – Botany, species and varieties.
23. Botanical and Horticultural classification – chemotaxonomy, propagation.
24. Climate and soil – cultivation aspects – Flowering, fruit set and development - Harvesting yield – storage and ripening.
25. Physiological disorders – Pests and diseases – Virus indexing – cross protection.
26. Moraceous fruits – Fig – origin and distribution – Area and production – composition and uses– species and varieties– climate & soil- propagation– cultivation – Flowering , pollination and fruit set – Fruit growth and development - Harvesting and yield – major problems.
27. Jack – Origin, distribution – Area and production – composition and uses – species and varieties – climate and soil – propagation - cultivation
    Flowering, fruit set and yield - Ripening and storage. Bread fruit and mulberry – General aspects of production.
28. Avocado – Origin and distribution – composition and uses – species, races and varieties – propagation – climate and soil – cultivation – Flowering, floral biology, fruit maturity, harvest and yield, pests and diseases.
29. Mangosteen and Pomegranate – Origin and distribution – composition and uses – Botany, species and varieties – propagation – climate & soil – cultivation aspects –Training and pruning - Flowering, fruit set and yield. Important pests and diseases.
30. Under-exploited and unexploited minor tropical and sub-tropical fruits – Annonas, Aonla, Rose apple, Jamun, West Indian Cherry, Kodumpuli, Tamarind, Passion fruit, Litchi,Rambutan etc – General aspects of cultivation.
31. Introduction to temperate fruits – physiology and seasonal influence.
32. Major temperate fruits – Apple, Pear - Varieties – Training and pruning – propagation and root stocks – High density planting .
33. Stone fruits – Peach and plum – varieties – Training and pruning – propagation and root stocks.
34. Berries – strawberry – prospects for commercial cultivation in the South Indian hill zones – protected cultivation technique. Other berries – general aspects.
35. Cherries & Apricot – Botany and varieties – General aspects.
36. Minor sub tropical and temperate fruits – General aspects.

Practical schedule

1. Visit to College orchard and acquainting with fruit plants
2. Studies on propagation of fruit crops
3. Mango – Botany, floral characters and identification of varieties
4. Mango – Field visit and study of cultural practices
5. Banana - Botany, floral characters and identification of varieties
6. Banana - Field visit and study of cultural practices
7. Pineapple - Botany, floral characters and identification of varieties
8. Pineapple - Field visit and study of cultural practices
9. Papaya - Field visit , study of cultural practices , identification of sex forms and identification of varieties
10. Guava and sapota – Study of cultural practices and identification of varieties
11. Moraceous and Annonaceous fruits - Identification of species and varieties
12. Grapes - Botany, floral characters and identification of varieties

13. Citrus - Botany, floral characters and identification of species and varieties
14. Identification of minor fruits
15. Identification of sub-tropical and temperate fruits
16. Visit to tissue culture laboratory and study of activities
17. Visit to fruit research stations, visit to commercial orchards
18. Practical Examination

Each student will raise two banana plants and maintain five different fruit trees to gain hands-on experience in the above practical aspects

Suggested Readings

1. Amar Singh, 1986. *Fruit Physiology and Production*. Kalyani Publishers, New Delhi.
2. Bose, T.K. and Mitra,S.K. 1985. *Fruits of India – Tropical and Subtropical*. Nayaprakash publications, Culcutta.
3. Chadha, K.L., Reddy, B.M.C. and Sikhamony,S.D. 1998. *Pineapple*. ICAR, New Delhi.
4. Chadha, T.R. 2001. *Text Book of Temperate Fruits*. ICAR , New Delhi.
5. Collins, J.L. 1968. *The Pineapple*. Leonard Hill, London.
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8. Galletta, G.J. and Himlrick, D.G.1989. *Small Fruit Crop Management*. Prentice Hall, New Jersey.
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11. Naik, K.C. 1949. *South Indian Fruits and Their Culture*. Varadachari Co., Madras.
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13. Radha, T. and Mathew, L. 2007. *Fruit Crops*, Vol. 2. Horticulture Science Series. New India Publishing Agency, New Delhi
14. Randhava, G.S. and Srivastava, K.C. *Citriculture in India*. Hindustan Publishing Co., New Delhi.
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19. Singh, R.1960. *Fruits*. National Book Trust, India.
20. Singh, R.N.1990. *Mango*. ICAR, New Delhi.
21. Stover, R.H. and Simmonds, N.W. 1987. *Bananas*. Longman scientific and Technical Publications, New York.
22. Veera Raghava Thataham, Jawaharlal,M. , Jeeva, S. and R.Rabindran.1996. *Scientific Fruit Culture*. Suri Associates, Coimbatore-2.
23. Westwood, M.N. 1978. *Temperate zone Pomology*. Freeman & Co. , Sanfransisco.
24. Winkler, A.J., Cook, J.A. , Kliewer, W.M. and Lider, L.A. 1962. *General Viticulture*. University of California Press, Berkely- Los Angeles- London.

6. Hort 3106 Post-harvest Management and value addition of horticultural crops (2+1)

Theory

Indian fruit and vegetable processing industry- Importance, problems & prospects- Physiology of maturity, ripening and senescence in fruits and vegetables and their chemical composition, - Post harvest losses - Pre and postharvest factors causing loss and spoilage- Post harvest management

techniques - Pre-cooling- grading and sorting- other operations- washing-sanitization- heat treatments- waxing- curing etc. Storage systems and storage disorders- Packaging technology- Government policies, regulations and specifications Marketing systems- Export promotion agencies- Principles and methods of preservation- drying and dehydration - Thermal processing- Preservation by ionizing radiations, chemical methods and fermentation- Recent advances in food preservation techniques- Post harvest technology of coconut, Arecanut, Oil palm, Rubber, Tea, Coffee, Cocoa & cashew, pepper, cardamom, ginger, turmeric, chilies, Tree spices, essential oil yielding crops and cut flowers- Industrial waste utilization

Practical

General guidelines for setting up of a small scale fruit and vegetable processing unit- FSSAI standards- Analytical methods in quality evaluation of raw material and product quality- TSS, Acidity, sugars, ascorbic acid etc. Preparation of important fruit and vegetable products- jams, jellies, pickles, candies, fermented and unfermented beverages, sauces- Commercial production of processed products- Preparation of coconut, pepper and ginger products- Estimation of spice essential oils- Solvent extraction of spice oleoresins - Familiarization with different processed products from spices and plantation crops- Commercial grades of plantation and spices- Visit to processing units of horticultural crops.

Lecture schedule

1,2	State of Indian fruit and vegetable processing industry- Importance of post harvest management of fruits, vegetables and other horticultural produce, problems & prospects
2.	Fruits and vegetables their chemical composition
3.	Physiology of maturity, ripening and senescence in fruits and vegetables
4.	Post harvest losses - Pre and post harvest factors causing loss and spoilage of fruits and vegetables
4,5	Post harvest management techniques for fruits and vegetables- Pre-cooling- methods-grading and sorting- other operations- washing-sanitization- heat treatments- waxing- curing etc.
6,7	Storage system- ambient, low temperature, modified and controlled atmosphere storage systems- storage disorders
8,9	Packaging technology - wholesale and retail packaging - packaging materials – advantages and disadvantages- consumer packaging.
10	Government policies, regulations and specifications for fresh and processed products- Marketing systems- Export promotion agencies and their role in export of fresh and processed products.
11	General principles and methods of preservation.
12	Principles of preservation by removal of water - pretreatments – blanching- sun drying, dehydration –methods.
13,14	Principles of preservation by application of heat (Thermal processing) -pasteurization – sterilization- Steps in canning and spoilage of canned products.
15,16	Principles of preservation by ionizing radiations, Principles of preservation by chemical methods- Role of sugar, brine, acid and other chemical, preservatives, other food additives.
17	Principles of preservation by fermentation- Alcoholic, acetic and lactic fermentation processes.
18.	Recent advances in food preservation techniques.
	Mid Term Examination
19,20	Post harvest technology of coconut
21	Post harvest technology of Arecanut.
22	Post harvest technology of Oil palm
23-24	Post harvest technology of Rubber
25	Post harvest technology of Tea
26	Post harvest technology of Coffee
27, 28	Post harvest technology of Cocoa & cashew

29. Post harvest technology of spices- general aspects
30. Post harvest technology of pepper
31. Post harvest technology of cardamom
32. Post harvest technology of ginger, turmeric & chilies
33. Post harvest technology of Tree spices
34. Post harvest technology of essential oil yielding crops
35. Post harvest technology of cut flowers
36. Industrial waste utilization

Practical schedule

1. Guidelines for establishing fruit and vegetable processing unit- FSSAI standards
2. Preliminary processing of fruits
3. Determination of total soluble solids
4. Preparation of fruit beverages (squash/ syrup/ RTS beverage)
5. Cashew apple processing
6. Preparation of fruit jam
7. Preparation of guava jelly
8. Grape wine preparation
9. Preparation of pickle
10. Tomato processing
11. Determination of acidity
12. Estimation of sugars
13. Commercial production of unfermented beverages- calculation
14. White pepper production by traditional retting method
15. Determination of volatile oil (Modified Clevenger method)
16. Estimation of oleoresin in spices
17. Visit to processing units of horticultural crops,familiarization with different processed products from spices and plantation crops
18. Practical Examination

Suggested Readings

1. John, P.J. 2008. *A hand book on Post Harvest management of Fruits and Vegetables*. Daya Publishing House. Delhi.147.
2. Kader, A.A. 2002. *Postharvest Technology of Horticultural Crops.* UCUCANR Publications. 535p.
3. Mitra, S. K. 1997. Postharvest Physiology and Storage of Tropical Fruits. CAB International, UK.
4. NIIR Board. 2012. *Food Packaging Technology Handbook (2nd Rev.Ed).* NIIR Project Consultancy Services. 749 p.
5. Panda, H. 2010. *Handbook on Spices and Condiments (Cultivation, Processing and Extraction).* Asia Pacific Business Press Inc. . 640 P.
6. Rajarathnam, S. and Ramteke, R.S.2011. *Advances in preservation and processing technologies of fruits and vegetables.*New India Publishing Agency, New Delhi
7. Ranganna, S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. Tata Mc. Graw Hill Publishing Company, New Delhi,1112p.
8. Sadasivam, S. and Manickam, A.1996. Biochemical methods. New Age International Pvt.Ltd. Publishers 256p.
9. Saraswathy, S., Preeti, J.L., Balasubramanyan, S., Suresh, J., Revathy, N. and Natarajan, S. 2008. *Postharvest management of horticultural crops.* AGRIBIOS (India).
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7. Hort.3207 Landscaping and Ornamental Horticulture (1+1)

Theory

Introduction to landscaping, gardening and commercial Floriculture. Components of landscapes and gardens, descriptions and functional uses – Living components – Non living components – Enrichment item. Garden enclosures, surfacing materials, roads and paths, enrichment items History of gardening trends in India – types of gardens – Styles in gardening – characteristics and components of English gardens, Mughal gardens, Japanese gardens, Persian, French and Italian gardens.Principles of landscaping. Designing and Preparation of landscape and garden plans. Functional uses of plants for different purposes. Components of gardens. Lawn Types of lawn grasses, methods of establishing, maintenance and rejuvenation of lawns. Annuals and herbaceous perennials Function and selection colour schemes, planting designs, Cultural practices,Shrubs and Trees Function and selection, planting and Cultural practices Trees for landscapes,avenue planting. Group planting and specimen planting, pruning and maintenance.Definition and classification Special requirements, functional values, planting, care and management, cultural practices of climber and creepers, cacti, succulents Ferns and palms. Specialized gardening techniques Roof garden, terrace garden, sunken garden, water garden, rock garden etc. Indoor gardening of plants Bonsai, vertical garden, tray garden, terrarium etc. Introduction to commercial Horticulture Present status of the cut flower industry in India and abroad – Area under flower crops – Problems and prospects of commercial floriculture in India with special reference to Kerala.Importance – classification, varieties grown, identification, environmental requirements, propagation, media and containers, planting, care and management, nutrition, plant protection, harvesting and marketing – Improvement of Rose Orchids, Anthurium, Jasmine and chrysanthemum, Bulbous plants (Gladiolus, Tuberose, Alpinia, Heliconia, Dahlia, amaryllis, ornamental gingers etc.Uses, classification, propagation, soil and climate, planting, care and management, harvesting, marketing of minor commercial flowers marigold, crossandra, gomphrena, gerbera, aster, celosia etc.Flower arrangement, flower shows and judging flower shows and arrangement, styles and designs

Practical

Identification of ornamental bulbous plants and propagation by specialized structures of bulbs, corms, tubers, rhizomes,familiarization with propagation structures, containers, gardening tools and implements, preparation of media,identification of ornamental shrubs and propagation of shrubs by cuttings,making of hedges, edges and edgings – training, trimming and maintenance of hedges and topiary,visit to a commercial nursery/flower production unit,iIdentification of lawn grasses, weeding, solarization and land preparation for lawn making,identification of ornamental annuals, seed bed preparation, sowing and aftercare,preparation of flower beds, flower borders and foundation covers,identification of commercial flower crops and ornamental herbaceous perennials,layout of lawns, planting, mowing and maintenance,propagation, planting and aftercare of monopodial orchids,propagation, planting and aftercare of sympodial orchids,propagation, planting and aftercare of Anthuriums,visit to the Instructional farm, identification of climbers and creepers and familiarization with propagation techniques of roses,propagation, planting and aftercare of other flower crops,familiarization with flower arrangement techniques and judging of plants and flowers in

shows,familiarization with the lay out of College garden and preparation of plans for gardens and landscapes.

Lecture schedule

1. Introduction to landscaping, gardening and commercial Floriculture – importance and prospects - Components of landscapes and gardens, descriptions and functional uses – Living components – Non living components – Enrichment items-Description and uses.
2. Garden enclosures, surfacing materials, roads and paths, enrichment items advantages and disadvantages examples.
3. History of gardening trends in India – types of gardens – Styles in gardening – characteristics and components of English gardens, Mughal gardens, Japanese gardens, Persian, French and Italian gardens.
4. Principles of landscaping – Designing and Preparation of landscape and garden plans – Outdoor room concept – Functional uses of plants for different purposes.
5. Lawn – Types of lawn grasses, methods of establishing lawn – Land preparation, planting, mowing, rolling, application of manures and fertilizers, irrigation, weed control, plant protection , rejuvenation of lawns
6. Annuals and herbaceous perennials – Function and selection – colour schemes, planting designs – Season and methods of planting – Cultural practices.
7. Shrubs and Trees – Types – Function, selection, planting, pruning, maintenance, rejuvenation – Trees for landscapes, avenue planting. Group planting and specimen planting, pruning maintenance rejuvenation.
8. Climber and Creepers – Cacti, succulents – Ferns and palms – Definition and classification – Special requirements, functional values, planting, care and management, cultural practices.

Mid Term Examination

9. Specialized gardening techniques – Roof garden, terrace garden, sunken garden, water garden, rock garden etc. Special requirements, establishment and maintenance.
10. Indoor gardening of plants – Function, selection, designs, types of indoor plants- Bonsai, environmental requirements – Containers and media, method of growing, special care for indoor plants, vertical garden, tray garden, terrarium etc.
11. Introduction to commercial Horticulture Present status of the cut flower industry in India and abroad – Area under flower crops – Problems and prospects of commercial floriculture in India with special reference to Kerala.
12. Rose – Importance and uses – Origin and distribution – Classification and varieties – Soil and climate – Propagation and planting – Care and management – Pruning, nutrition, irrigation, plant protection, harvesting, marketing of loose flowers, cut flowers and perfumery roses, protected cultivation for export.
13. Orchids – Importance – classification, varieties grown, identification, environmental requirements, propagation, media and containers, planting, care and management, nutrition, plant protection, harvesting and marketing – Improvement.
14. Anthurium – Importance, classification, species and varieties, environmental requirements, propagation, containers and media, planting, care and management, nutrition, harvesting and marketing, Improvement.
15. Jasmine and chrysanthemum – Importance and uses – classification and varieties, soil and climate, propagation, planting, special cultural techniques – nutrition, plant protection, harvesting and marketing.
16. Bulbous plants – classification, uses, commercial value, propagation, soil and climate – planting – Care and management – harvesting, storage of planting materials (Gladiolus, Tuberose, Alpinia, Heliconia, Dahlia, amaryllis, ornamental gingers etc.
17. Minor commercial flowers – marigold, crossandra, gomphrena, gerbera, aster, celosia etc. – Uses, classification, propagation, soil and climate, planting, care and management, harvesting, marketing.

18. Flower arrangement, flower shows and judging principles of flower arrangement – styles and designs – tools containers and accessories, designs for special occasions, collection and preparation of flowers and foliage, vase solutions preparation and preservation of dry flowers and foliage, judging of flower and foliage arrangements and shows.

Practical schedule

1 Identification of ornamental bulbous plants and propagation by specialized structures – bulbs, corms, tubers, rhizomes etc.
2 Familiarization with propagation structures, containers, gardening tools and implements, preparation of media.
3 Identification of ornamental shrubs and propagation of shrubs by cuttings
4 Making of hedges, edges and edgings – training, trimming and maintenance of hedges and topiary.
5 Visit to a commercial nursery/flower production unit.
6 Identification of lawn grasses, weeding, solarization and land preparation for lawn making.
7 Identification of ornamental annuals, seed bed preparation, sowing and aftercare.
8 Preparation of flower beds, flower borders and foundation covers.
9 Identification of commercial flower crops and ornamental herbaceous perennials.
10- 11 Layout of lawns, planting, mowing and maintenance.
12 Propagation, planting and aftercare of monopodial orchids.
13 Propagation, planting and aftercare of sympodial orchids.
14 Propagation, planting and aftercare of Anthuriums.
15 Visit to the Instructional farm, identification of climbers and creepers and familiarization with propagation techniques of roses.
16 Propagation, planting and aftercare of other flower crops,familiarization with flower arrangement techniques and judging of plants and flowers in shows.
17. Familiarization with the lay out of College garden and preparation of plans for gardens and landscapes.
18. Practical Examination

Suggested Readings

1. Bose,T.K. and Mukherjee, D. 1972. *Gardening in India*. Oxford and IBH Publishing Company, Calcutta.
2. Bose, T.K., Maiti, R.G., Dhuna, R.S. and Das., P. (eds) 1909. *Floriculture and Landscaping*. Naya Prakash, Calcutta, India.
3. Bhattacharjee,S.K.(ed). 2006. *Advances in Ornamental Horticulture* Vol. I to VI. Pointer Publishers, Jaipur.
4. Chadha, K.L. and Choudhury, B. 1992. *Ornamental Horticulture in India*., ICAR, New Delhi.
5. Gilbert, R. 1988. *200 House plants any one can grow*. Dorling Kindersley Ltd., London. 144p.
6. Jindal, S.L. 1987. *Flowering shrubs in India.* Publications Division, Govt. of India, New Delhi. 175p.
7. Joiner.J.N. 1981. *Foliage Plant Production*. Prentice Hall Inc., London.
8. KAU(Kerala Agricultural University) 2011. Package of Practices Recommendations: Crops(14th Ed). Kerala Agricultural University, Thrissur. 360p.
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11. Randhawa.G.S. and Mukhopadhyay. A. 1986. *Floriculture in India*. Allied Publishers, New Delhi. 656p.

12. Rajeevan, P.K., Singh, K.P. and Valsalakumari, P.K .2003. ed. *Bulbous Flowers*. Indian Society of Ornamental Horticulture Division of Floriculture & Landscaping, IARI, New Delhi.

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14. Santapau, H. and Heary, A.N. 1984. *A Dictionary of flowering plants in India*. CSIR, New Delhi. 198p.

15. Sheela, V.L. 2008. *Flowers for trade*. New India Publishing Agency, New Delhi.379p.

16. Sidhu, S.S. 2016.*Ornamental Horticulture*. New India Publishing Agency,New Delhi. 485p.

17. Swarup.V. 1993. *Indoor Gardening*, ICAR, New Delhi.

AGRICULTURAL ENTOMOLOGY

1. Ento.1201 Fundamentals of Entomology (2+1)

Theory

Definition and scope of Agricultural Entomology. History of Entomology in India. Insects in relation to man. Economic classification of insects. Dominance of insects. Classification of phylum Arthropoda. Relationship of class insecta with other classes of Arthropoda.
External Morphology: Structure and functions of integument. Structure of head, thorax and abdomen. Body appendages (including genitalia) and their modifications. Sound and light producing organs.Anatomy and General Physiology: Structure and function of digestive, circulatory, respiratory, excretory, reproductive, endocrine, exocrine, nervous systems and sense organs.Development: Embryonic and post embryonic development. Types of metamorphosis. Types of immature stages.Principles and practices of taxonomy, functions of taxonomy, role of taxonomy in pest management. International Code of Zoological Nomenclature (ICZN). Insects and their allies. Super class -Hexapoda and class-Insecta. Classification of insects up to family. Important families, their identifying characters and economic importance.

Practical

Studies and identification of external morphology of a typical insect,methods of collection and preservation of insects,head,types of head,types of antennae,study of mouth parts of cockroach, honey bee,study of mouth parts of housefly, plant bug and butterfly,types of legs,types of wings,types of abdominal appendages,study of digestive system of cockroach,types of metamorphosis,types of larva & pupae,identification and acquaintance of the class- Collembola & Thysanura; order - Odonata and Orthoptera,Phasmatodea, Dermaptera Embioptera, Blattodea, Mantodea, Isoptera and Phthiraptera,identification and acquaintance with the important families of orders: Hemiptera, Thyasanoptera and Neuroptera,Coleoptera,Diptera,Lepidoptera, Hymenoptera

Lecture schedule

1. Definition, scope and history of agricultural entomology in India. Insects in relation to man. Economic classification of insects
2. Dominance of insects. Classification of phylum Arthropoda. Relationship of class Insecta with other classes of Arthropoda .
3. External morphology - structure and functions of integument and moulting.
4. Body regions: Head - areas, sulci and sutures - types of head - appendages - antennae - structure and modifications.
5. Mouthparts: Generalised type.
6. Piercing and sucking type - subtypes. Siphoning type.
7. Sponging type, chewing and lapping type, rasping and sucking type.
8. Thorax - structure. Legs - structure and modifications.
9. Wings - structure, venation, wing articulation and modification of wings.
10. Abdomen - structure and appendages including external genitalia.
11. Digestive system - structure and functions.
12. Circulatory system and excretory system.
13. Respiratory system.
14. Reproductive system.
15. Nervous system and sense organs.
16. Exocrine and Endocrine systems.
17. Insect development - embryonic and post embryonic.
18. Types of metamorphosis and type of immature stages.

Mid Term Examination

19. Principles and practices of taxonomy. Zoological nomenclature - ICZN, Type concept. Role of taxonomy in pest management. Insects and their allies. Super class-hexapoda and class-Insecta.
20. Classification of super class: Hexapoda upto orders (Kristensens classification), identifying characters of class Collembola, Protura and Diplura. Identifying characters of orders and economically important families of class Insecta
21. Order Archeognatha, Thysanura, Ephemeroptera
22. Order Odonata (Sub order (Sub order)-Anisoptera, Zygoptera) Plecoptera, Grylloblattodea.
23. Order Orthoptera (Sub order. Ensifera – families Schizodactylidae, Tettigonidae, Gryllidae, Gryllotalpidae) (Sub order Caelifera - Acrididae, Tetrigidae Tridactylidae)
    Order Phasmatodea (Family: Phyllidae, Phasmatidae)
    Mantophasmatodea, Dermaptera, Embioptera
24. Blattodea (Blattidae) Mantodea (Mantidae), Isoptera (Termitidae), Zoraptera, Psocoptera & Phthiraptera (Menoponidae, Pediculidae)
25-26. Order Hemiptera
    Sub order. Heteroptera – Gerridare, Nepidae, Belostomatidae, Notonectidae, Cimicidae, Miridae, Tingidae, Reduviidae, Lygaeidae, Pyrrhocoridae, Coreidae, Alydidae, Plataspididae, Pentatomidae
    Sub order. Sternorrhyncha - Psyllidae, Aleyrodidae, Aphididae, Coccidae, Diaspididae, Pseudococcidae
    Sub order. Auchenorrhyncha - Cicadidae, Membracidae, Cercopidae, Delphacidae, Cicadellidae, Fulgoridae
27. Thysanoptera – Sub order. Terebrantia (Thripidae), Sub order. Tubulifera Neuroptera - (Chrysopidae, Hemerobiidae, Mantispidae)
28-29. Coleoptera
    Sub order. Adephaga - Carabidae, Gyrinidae, Dytiscidae
    Sub order Polyphaga - Hydrophilidae, Staphylinidae, Scarabaeidae, Buprestidae, Elateridae, Bostrichidae, Coccinellidae, Tenebrionidae, Meloidae, Cerambycidae, Chrysomelidae, Curculionidae
    Sub order. Myxophaga
30. Mecoptera, Siphonaptera (Pulicidae), Strepsiptera (Stylopidae)
31-32. Diptera
    Sub order. Nematocera - Culicidae, Cecidomyiidae
    Sub order. Brachycera- Tabanidae, Asilidae
    Sub order Cyclorrhapha - Syrphidae, Tephritidae, Agromyzidae, Drosophilidae, Muscidae, Calliphoridae, Tachinidae
33-34. Trichoptera & Lepidoptera (Gracillaridae, Plutellidae, Gelechidae, Tortricidae, Limacodidae, Pterophoridae, Pyralidae, Crambidae, Geometridae, Hesperiidae, Papilionidae, Pieridae, Nymphalidae, Lycaenidae, Bombycidae, Sphingidae, Lymantridae, Arctidae, Noctuidae
35-36. Hymenoptera
    Sub order. - Symphyta - Tenthridinidae
    Sub order.-Apocrita- Ichneumonidae, Braconidae, Evanidae, Bethylidae, Chalcididae, Eulophidae, Trichogrammatidae, Vespidae, Formicidae, Sphecidae, Megachilidae, Anthophoridae, Apidae, Platygasteridae.

Practical schedule

1. External morphology of a typical insect.
2. Methods of collection and preservation of insects.
3. Head - areas, sulci and sutures. Types of head.
4. Types of antennae.

5. Study of mouth parts of cockroach, honey bee.
6. Study of mouth parts of housefly, plant bug and butterfly.
7. Types of legs.
8. Types of wings.
9. Types of abdominal appendages.
10. Study of digestive system of cockroach.
11. Types of metamorphosis.
12. Types of larva & pupae.
13. Identification and acquaintance of the class- Collembola & Thysanura; order - Odonata and Orthoptera
14. Identification and acquaintance of the orders: Phasmatodea, Dermaptera Embioptera, Blattodea, Mantodea, Isoptera and Phthiraptera.
15. Identification and acquaintance with the important families of orders: Hemiptera, Thyasanoptera and Neuroptera
16 Identification and acquaintance with the important families of orders: Coleoptera.
17 Identification and acquaintance with the important families of orders: Diptera,Lepidoptera, Hymenoptera
18. Practical Examination

Suggested Readings

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2. Champman, R. F. 1980. *The Insect - Structure and Function* - English Language Book Society, London, 819 p.
3. Gullan, P. J. and Cranston, P. S. 2014. *The insects: an outline of entomology*. (8th Ed.) Wiley Blackwell, 595 p.
4. Metcalf, C. L. and Flint, W. P. 1973. *Destructive and Useful Insects*. Tata Mc Graw Hill Publishing Co. New Delhi, 1087 p.
5. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. 1979. *General and Applied Entomology*. Tata Mc Graw Hill Publishing Co. New Delhi, 589 p.
6. 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, 1137 p.
7. Pant, N. C. and Ghai, S. 1973. *Insects Physiology and Anatomy*. I CAR. New Delhi, 332 p.
8. Richards, O. W. and Davies, R. G. 1977. *Imms General Textbook of Entomology* Vol. I Chapman and Hall, London, 405 p.
9. Richards, O. W. and Davies, R. G. 1977. *Imms General Textbook of Entomology*. Vol. II Chapman and Hall, London, 1353 p.
10. Snodgrass, R. E. 1935. *Principles of Insect Morphology*. Tata Mc Graw Hill Publishing Co. New Delhi, 667 p.

2. Ento. 2102 Insect Ecology and Integrated Pest Management (2+1)

Theory

Insect ecology: Scope and definition. Population dynamics. Life tables. Inter specific and intra specific relations. Balance of life in nature. Pest-definition and categories. Pest monitoring and surveillance. Assessment of pest population and damage. Integrated Pest Management: Principles of IPM, concept of economic threshold and economic injury levels, tools of IPM - advantages and disadvantages. Basic concept of host plant resistance. Biocontrol of pests and weeds: concepts, advantages and disadvantages. Microbial control. Regulatory control, plant quarantine and phytosanitory certificate. Pesticides: Insecticide act and rules. Insecticides – classification, mode of

action and formulations - advantages and limitations - mammalian toxicity and environmental pollution. Insecticide appliances. Newer trends in insect pest management – pheromones, Insect Growth Regulators, Chitin synthesis Inhibitors, biotechnological methods.

Practical

Study of agro eco systems,identification of the types of insect damages on crop plant,sampling techniques for the assessment of insect population,techniques for estimation of crop damages,familiarisation with the mechanical,physical and cultural methods of pest management,light and bait traps,pheromone traps,identification of insect predators,insect parasitoids,familiarisation with the formulations of conventional and new generation insecticides,calculation of field dose of insecticides and practices in field application on different crops,preparation and application of insecticides of plant origin,maintenance and operation of common plant protection equipments

Lecture schedule

1. Insect ecology - scope and definition,
2. Population dynamics- Effect of biotic & abiotic factors
3. Balance of life- Biotic potential, Environmental resistance-intra and interspecific relations
4. Life table studies. Natality, mortality, intrinsic rate of increase, stable age distribution.
5. Pests – definition, categories of pests - causes of pest outbreaks
6. Pest monitoring and surveillance
7. IPM- Introduction, importance, principles - advantages and limitations
8. Concepts of general equilibrium position, economic injury level and economic threshold level. Tools of IPM
9. Mechanical, physical and Cultural methods of pest management.
10. Host plant resistance- definitions –concepts, mechanisms of host plant resistance
11. Biological methods - definition - methods – Advantages and limitations

12-13. Macrobiological methods- Predators, parasitoids

14. Microbial methods- Bacteria, fungi and viruses
15. Regulatory methods- Quarantine – Acts - Phytosanitary certification
16. Chemical methods – History-advantages
17. Chemical methods - Disadvantages - Resistance, Resurgence and Replacement, mammalian toxicity, LD_{50}
18. Insecticides Act- CIB-Registration-Labeling

Mid Term Examination

19-20. Insecticides - classification - mode of action.

21. Formulation of insecticides - newer trends in formulations.

22-23. Candidate insecticides in different groups –Cyclodienes, organophosphates, carbamates, synthetic pyrethroids

24-25. Novel insecticides- Neonicotinoids, Phenyl pyrazoles, Ryanodines, Avermectins

26. Botanical insecticides
27. Rodenticides, Acaricides and Fumigants
28. Handling and safe use of insecticides- Symptoms of poisoning- First aid and Antidotes
29. Environmental-toxicology - residue hazards and pollution in air, soil, water and food commodities.
30. Tolerance levels - maximum residue limits - waiting periods
31. Plant protection equipments - classification -working principles.
32. Plant protection equipments - operation and maintenance.
33. Repellants, antifeedants and attractants
34. Newer trends in pest management-Pheromones, IGRs
35. CSI, genetic control
36. Biotechnology in pest management-transgenic crops

Practical schedule

1. Study of agro eco systems
2. Identification of the types of insect damages on crop plant.
3. Sampling techniques for the assessment of insect population.
4. Techniques for estimation of crop damages.
5. Familiarisation with the mechanical and physical methods of pest management
6. Familiarisation with cultural methods
7. Light and bait traps.
8. Pheromone traps
9. Identification of insect predators
10. Identification of insect parasitoids
11-13. Familiarisation with the formulations of conventional and new generation insecticides
14- 15. Calculation of field dose of insecticides and practices in field application on different crops.
16. Preparation and application of insecticides of plant origin
17. Maintenance and operation of common Plant Protection equipments.
18. Practical Examination

Suggested Readings

1. Ananthakrishnan, T. N. and Viswanathan, T. R. 1983. *General Animal Ecology*. Mac Millan India Ltd. Madras, 357 p.
2. Atwal, A. S. and Dhaliwal, G. S. 2003. *Agricultural Pests of South Asia and their Management.* Kalyani Publishers, 498 p.
3. Bindra, O. S and Singh, H. 1977. *Pesticide Application equipment*. Oxford and IBH, New Delhi, 307 p.
4. David, B. V. and Ramamurthy, V. V. 2016. *Elements of Eonomic Entomology* (8th Ed.) Brillion Publishing, 400 p.
5. Dhaliwal, G. S. and Arora, R. 2001. *Integrated Pest Management- concepts and approaches*, 369 p.
6. Fenemore, P. P. and Praksh, A. 2006. *Applied Entomology*. Wiley Eastern Ltd. Bangalore, 269 p.
7. Gour, T. B. and Sridevi, D. 2012. *Chemistry, toxicity and mode of action of insecticides.* Kalyani publishers, Bangalore, 316 p.
8. Metcalf, R. L. and Luckman, W. H. 1994. *Introduction to Insect Pest Management*. John Wiley and sons, New York, 605 p.
9. Nair, K. K., Ananthakrishnan, T. N. and David, B. V. 1976. *General and applied Entomology*. Tata Mc Graw Hill Publishing company Ltd. New Delhi, 589 p.
10. Pedigo L. P. and Rice M. E. 1996. *Entomology and Pest Management*. Prentice-Hall, India, 646 p.
11. Romoser, W. S. and Stoffolano, J. G. 1998. *The Science of Entomology* (4th Edn.). WCB-Mc Graw-Hill, Boston, 605 p.

3. Ento. 2203 Pests of crops and their management I (1+1)

Theory

Distribution, bioecology, nature and symptoms of damage and management strategies of major insect pests of Field crops: rice, wheat, maize, sorghum, ragi, sugarcane, cotton and oil seeds – groundnut, sesamum, castor, sunflower and mustard, pulses.

Vegetable crops: solanaceous vegetables – brinjal, chilli, tomato, cucurbitaceous vegetables-bittergourd, snake gourd, cucumber & pumpkin. Cruciferous vegetables – cabbage and cauliflower; bhindi, amaranthus, moringa and curry leaf, polyhouse vegetables; Tuber crops: tapioca, sweet

potato, yam; Fruit crops: banana, mango, jack, papaya, pineapple, citrus, guava, pomegranate, sapota, apple and grape vine.

Practical

Identification of life stages and study of nature and symptoms of damage of the major pests of rice,identification of natural enemies in rice ecosystem,identification of life stages and study of nature and symptoms of damage of the major pests of sugarcane, cotton, ground nut, castor, sesamum, solanaceous vegetables, cucurbitaceous vegetables, bhindi, cowpea, cabbage, cauliflower, curry leaf and moringa,visit to vegetable garden and identification of the pests and their symptoms of attack,identification of life stages and study of nature and symptoms of damage of the major pests of tuber crops,banana,mango,jack, papaya,pineapple,citrus, guava, sapota & pomegranate,visit to orchards,identification of the pests and symptoms of attack

Lecture schedule

1. Introduction

2 . Biology and nature and symptoms of damage and management of the important pest of Rice
3. Biology and nature and symptoms of damage and management of the important pest of Rice
4. Biology and nature and symptoms of damage and management of the important pest of Wheat, Maize, Sorghum and Ragi
5. Biology and nature and symptoms of damage and management of the important pest of Sugarcane.
6. Biology and nature and symptoms of damage and management of the important pest of Cottton
7. Biology and nature and symptoms of damage and management of the important pest of Oil seeds
8. Biology and nature and symptoms of damage and management of the important pest of Brinjal, chilli, tomato and bhindi
9. Biology and nature and symptoms of damage and management of the important pest of Bitter gourd, snake gourd, cucumber and pumpkin

Mid Term Examination

10. Biology and nature and symptoms of damage and management of the important pest of Cabbage, cauliflower and polyhouse vegetables
11. Biology and nature and symptoms of damage and management of the important pest of Cowpea
12. Biology and nature and symptoms of damage and management of the important pest of Amaranthus, moringa and curry leaf
13. Biology and nature and symptoms of damage and management of the important pest of Tapioca, sweet potato, yam
14. Biology and nature and symptoms of damage and management of the important pest of Banana
15. Biology and nature and symptoms of damage and management of the important pest of Mango
16. Biology and nature and symptoms of damage and management of the important pest of Jack, papaya & pineapple
17. Biology and nature and symptoms of damage and management of the important pest of Citrus, guava, sapota & pomegranate
18. Biology and nature and symptoms of damage and management of the important pest of Apple & grapevine.

Practical schedule

1. Identification of life stages and study of nature and symptoms of damage of the major pests of rice.

2. Identification of natural enemies in rice ecosystem.
3. Identification of life stages and study of nature and symptoms of damage of the major pests of sugarcane.
4. Identification of life stages and study of nature and symptoms of damage of the major pests of cotton
5. Identification of life stages and study of nature and symptoms of damage of the major pests of ground nut, castor, sesamum
6. Identification of life stages and study of nature and symptoms of damage of the major pests of solanaceous vegetables
7. Identification of life stages and study of nature and symptoms of damage of the major pests of cucurbitaceous vegetables
8. Identification of life stages and study of nature and symptoms of damage of the major pests of bhindi
9. Identification of life stages and study of nature and symptoms of damage of the major pests of cowpea
10. Identification of life stages and study of nature and symptoms of damage of the major pests of cabbage, cauliflower, curry leaf and moringa
11. Visit to vegetable garden and identification of the pests and their symptoms of attack.
12. Identification of life stages and study of nature and symptoms of damage of the major pests of tuber crops
13. Identification of life stages and study of nature and symptoms of damage of the major pests of banana
14. Identification of life stages and study of nature and symptoms of damage of the major pests of mango
15. Identification of life stages and study of nature and symptoms of damage of the major pests of jack, papaya & pineapple
16. Identification of life stages and study of nature and symptoms of damage of the major pests of citrus, guava, sapota & pomegranate
17. Visit to orchards-identification of the pests and symptoms of attack
18. Practical Examination

Suggested Readings

1. Atwal, A. S. 1977. *Agricultural pests of India and south East Asia*. Kalyani Publishers, Ludhiana, 529 p.
2. Atwal, A. S. and Dhaliwal G. S. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publishers, 489 p.
3. Ayyar, T. V. R. 1950. *Handbook of Economic Entomology for South India* (1st Ed). Govt. Press, Madras, 528 p.
4. Butani, D. K, 1979. *Insects and Fruits*. Periodical Expert Book Agency, New Delhi, 415 pp.
5. David, B. V. and Ramamurthy, V. V. 2016. *Elements of Eonomic Entomology* (8th Ed). Brillion Publishing, 400 p.
6. Hill, D. S. 1987. *Agricultural Insect Pests of Tropics and their control*. Cambridge University Press, London, 758 p.
7. Lefroy, H. M. 1909. *Indian Insect Life*. Thacker, Spink and Co. Calcutta, 786p.
8. Nair, M. R. G. K., 1986. *Insects and Mites of Crops in India*. ICAR, 408 p.
9. Nair, M. R. G. K. 1989. *A Monograph on crop Pests of Kerala and Their Control*. 2nd Ed. Kerala Agrl. University Press, Mannuthy, 199 p.
10. Ranjith, A. M. 2013. Identification *and Management of Horticultural Pests*. New India Publishers, 348 p.
11. Srivastava, K. P. 1993. *A text book of Applied Entomology* Vol II. Kalyani Publications , Ludhiana, Chennai, New Delhi, 424 p.

4. Ento. 3104 Pests of crops and their management II (1+1)

Theory

Distribution, biology, nature and symptoms of damage and management strategies of major insect of Plantation crops: coconut, arecanut, rubber, cashew, tea, coffee and cocoa; Spices: pepper, cardamom, ginger, turmeric, nutmeg, cinnamon and clove; Ornamentals – rose, jasmine, orchid, anthurium, gladiolus, chrysanthemum, lily, tabernemontana and turf grass; medicinal and aromatic plants – lemongrass, citronella, eucalyptus, palmorosa, vetiver**;** forest trees - teak. Stored products: Primary feeders, secondary feeders, principles of storage to reduce storage losses; Household, public health poultry and livestock.

Practical

Identification of life stages and symptoms of damage and management of major pests of coconut,arecanut, rubber, cashewtea, coffee and cocoa,pepper, ginger,turmeric,cardamom, nutmeg, cinnamon,clove,ornamental plants,aromatic and medicinal plants,forest trees,pests of stored products,acquaintance with fumigants and method of room cover fumigation,identification of life stages and management of household pests,pests of livestock, poultry and public health,field vist to plantations and FCI godowns.

Lecture schedule

1. Introduction
2-3. Biology and nature and symptoms of damage and management of the pests of coconut
4. Biology and nature and symptoms of damage and management of the pests of arecanut & rubber
5. Biology and nature and symptoms of damage and management of the pests of cashew
6. Biology and nature and symptoms of damage and management of the pests of tea
7. Biology and nature and symptoms of damage and management of the pests of coffee & cocoa
8. Biology and nature and symptoms of damage and management of the pests of pepper
9. Biology and nature and symptoms of damage and management of the pests of cardamom, ginger and turmeric

Mid Term Examination

10. Biology and nature and symptoms of damage and management of the pests of nutmeg, cinnamon and clove
11. Biology and nature and symptoms of damage and management of the pests of ornamental plants: rose, jasmine orchids, anthurium, gladiolus, chrysanthemum, lily, Tabernemontana and turfgrass
12. Biology and nature and symptoms of damage and management of the pests of aromatic plants and medicinal plants- Indian indigo, *Plumbago*, Indian long pepper, *Tylophora*, basil, kacholam and aswagandha
13. Biology and nature and symptoms of damage and management of the pests of forest trees: teak, ailanthus and bamboo
14. Problems of storage of agricultural products in India-storage losses-principles of grain storage -sources and kinds of insect infestation in storage-storage practices in India
15. Biology, nature and symptoms of damage of major pests of stored products.
16. Management of pests of stored products
17. Pests of household and public health and their management
18. Pests of livestock and poultry and their management

Practical schedule

1&2. Identification of life stages and symptoms of damage and management of major pests of coconut.
3. Arecanut, rubber & cashew.
4. Tea, coffee and cocoa
5. Pepper, ginger & turmeric.
6. Cardamom, nutmeg, cinnamon and clove.
7. Ornamental plants.
8. Aromatic and medicinal plants.
9. Forest trees.
10. Pests of stored products.
11. - do-
12. Acquaintance with fumigants and method of room cover fumigation.
13. Identification of life stages and management of household pests.
14. Pests of livestock, poultry and public health.
15 – 17 Field vist to plantations and FCI godowns.
18. Practical Examination

Suggested Readings

1. Atwal, A. S. 1976. *Agricultural pests of India and South- East Asia*. Kalyani Publishers, New Delhi, 528 p.
2. Atwal, A. S. and Dhaliwal G.S. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publishers, 489 p.
3. Bhargava, M.C. 2009. *Pests of Stored Grains and their Management*. New India Publishing Agency, 264 p.
4. David, B. V. and Ramamurthy, V. V. 2016. *Elements of Eonomic Entomology* (8th Ed.). Brillion Publishing, 400 p.
5. Khare, B.P. 2004. Stored *Grains Pests and their Management*. Kalyani Publishers, 314 p.
6. Munro, J. W. 1966. *Pests of stored Products*. Hutchinson & Co. Ltd. London, 234 p.
7. Nair, M. R. G. K., 1976 Insects and Mites of Crops in India. ICAR, 408 p.
8. Nair, M. R. G. K. 1989. *A Monograph on Crop Pests of Kerala and Their Control*. 2nd Ed. Kerala Agrl. University Press, Mannuthy, 199 p.
9. Pingale, S. V. 1978. *Handling and storage of Foodgrains*. ICAR New Delhi, 150 p.
10. Rao, P. A., Mathur, K. C. and Pasalu, I. C. 1987. *Rice Storage and Insect Pest Management.* B.R. Publishing Corporation, Delhi, 350 p.
11. Ranjith A.M. 2013. *Identification and Management of Horticultural Pest*s. New India Publishers, 348 p.
12. Srivastava, K.P. 1993. *A text book of Applied Entomology*, Vol II. Kalyani Publications , Ludhiana, Chennai, New Delhi, 424 p.

12. Ento. 3205 Management of beneficial insects and non insect pests (1+1)

Theory

Honey bees: Species of honey bee. Morphology, structural adaptations, life history and habits. Types of bee hives and accessories. Bee pasturage. Care and management of an apiary. Bee hive products. Diseases and enemies of honey bees and their management. Meliponiculture. Scope of beekeeping in Kerala.

Silkworms: Species of silk worms and their bio-ecology. Rearing of mulberry silkworm. Diseases and enemies of silkworm and their management. Scope of sericulture in Kerala.

Lac insects: Lac culture and its economic importance. Processing of lac. Enemies of lac insect.
Helpful insects: Insect pollinators, predators, parasites, weed killers, soil builders, scavengers and insects used for scientific investigations.Plant Parasitic Mites: Introduction to acarology, morphology and anatomy of phytophagous mites, distingushing characters of families and important genera of phytophagous mites. Mites infesting crops in Kerala. Mites as vectors of plant diseases. Management of mites. Rodents: General characters of important pest species, their biology, habit and management.Birds and other vertebrate and invertebrate pests: Nature of damage and management.Acaricides, rodenticides and molluscicides. Formulations and applications.

Practical

Life stages and castes of honey bees,apiary equipments,honey extraction, wax processing and identification of bee diseases and enemies,field practice of apiary management techniques,meliponiculture,acquaintance with different silk worm species,sericulture equipments,acquaintance with rearing of mulberry silk worm,lac insects and their enemies,identification of parasites & predators, insect pollinators, scavengers & soil builders,important phytophagous mites and symptoms of attack on crops,familiarisation with acaricides and preparation of spray solutions and its applications,identification of important rodent species and traps,other vertebrate pests, slugs and snails of crops,acquiantance with rodenticides and molluscides.

Lecture schedule

1. Apiculture: Beekeeping in India, honey bees-types and castes.
2. Bee pasturage, bee keeping equipments, migratory bee keeping, seasonal management
3. Apiary management - honey extraction, processing of honey, bee wax.
4. Bee enemies and bee diseases. Meliponiculture
5. Sericulture: Scope of sericulture in Kerala. Species of silkworms and their bioecology- Eri, Tassar and Muga silk worms.
6. Rearing of mulberry silkworm. Sericulture equipments.
7. Diseases and enemies of silkworms and their management. Marketing and processing of cocoons
8. Lac culture - bioecology of lac insects – host trees – strains of lac insects - processing of lac - enemies of Lac insect.
9. Helpful insects: Insects as pollinators, parasites, predators. Scavengers, soil builders and insects used for scientific investigations.

   Mid Term Examination
10. Introduction to acarology-distinguishing characters of ticks and mites. Significance of mites. Brief history. Role of acarine in Agriculture. Direct and Indirect damages, seasonal occurrence-dispersal.
11. General morphology and anatomy of phytophagous mites-body divisions- gnathosomal and idiosomal structures-digestive, excretory, circulatory, reproductive and nervous systems-sense organs. Phytophagous mites-distinguishing characters of families-Tetranychidae, Tenuipalpidae, Tarsonemidae and Eriophyidae-life cycle, nature and symptoms of damage.
12. Mites infesting crops in Kerala-Plantation crops: Tea, coconut, arecanut. Vegetables: amaranthus, bhindi, brinjal, tomato, cucurbits. Pulses: Cowpea and redgram. Sugarcane. Tuber crops: Tapioca. Fruit crops: Mango, citrus. Ornamental plants: Jasmine, rose and orchids.
13. Mite transmission of plant diseases. Management of mites-cultural, botanical, biological methods. Chemicals-acaricides.
14. Rodents general features- squirrels and porcupines. Rats and mice- general features- identifying characters of rats and mice of agricultural importance, their habits and habitats.

15. Rodent management- principles and methods of control- physical, biological and mechanical methods.
16. Rodenticides- acute poisons, chronic poisons, fumigants, fumigation, baits, baiting and rat proofing. Rodent control campaign- rodent eradication programmes, organization and implementation.
17. Vertebrate pests- birds and mammals injurious to agriculture, nature of damage and their management.
18. Snails and slugs – habits and habitats, economic importance and management.

Practical schedule

1. Life stages and castes of honey bees
2. Apiary equipments.
3-4. Honey extraction, wax processing and identification of bee diseases and enemies.
5. Field practice of apiary management techniques.
6. Meliponiculture
7. Acquaintance with different silk worm species. Sericulture equipments.
8. Acquaintance with rearing of mulberry silk worm.
9. Lac insects and their enemies. Identification of parasites & predators.
10. Identification of insect pollinators, scavengers & soil builders
11-12. Identification of important phytophagous mites and symptoms of attack on crops.
13. Familiarisation with acaricides and preparation of spray solutions and its applications.
14-15. Identification of important rodent species and traps.
16. Identification of other vertebrate pests, slugs and snails of crops.
17. Acquiantance with rodenticides and molluscides.
18. Practical Examination

Suggested Readings

1. David, B. V. and Kumaraswamy, T. 1996. *Elements of Economic Entomology*. Popular Book Depot, Madras, 507 p.
2. Grout, R. A. 1963.*The Hive and the Honey bee*. Dadant and sons Inc. Hamilton, llinois, 633 p.
3. Gupta, S. K. 1985. *Hand Book Plant mites of India*. Zoological Survey of India, Calcutta, 520 p.
4. Haq,M.A and Remani, N. 1992. *Mites and Environment*. Anjengo publications, Kerala,722 p.
5. Helle, W.1985 *Spider mites Their biology, natural enemies and their control.* Elsevier, 458 p.
6. Jeppson, L. R., Keifer, H. H. and Baker, E. W. 1975. *Mites injurious to economic plants.* University of California Press, 614 p.
7. Krantz. G. W. and Walter D.E. 2009. *A Manual of Acarology*(3rd Ed.). Texas Tech University Press, 807 p.
8. Lindquist, E. E., Bruin,J. and Sabelis, M.W. 1996. *Eriophyid mites: Their biology, natural enemies and control*. Elsevier, 785 p.
9. Metcalf, C. L. and Flint, W. P. 1973. *Destructive and useful insects*. Tata Mc. Graw Hill Publishing Co. New Delhi, 1087 p.
10. Mishra, R. C. 1995. *Honey bees and their management*. ICAR New Delhi, 168 p.
11. Morse, K. K., Ananthakrishnan, T. N. and David, B. V. 1979. *General and Applied Entomology*. Tata Mc Graw Hill Publishing Co. New Delhi,. 589 p.
12. Nair, M. R. G. K. 1976. *Insect and Mites of Crops in India*, ICAR. New Delhi, 408 p
13. Prakash, I. and Mathur, R. P. 1987. *Management of Rodent Pests*. ICAR, New Delhi,133p.
14. Sadana, G. L. 1997. *False spider mites infesting crops in India*. Kalyani publishers, 201 p.
15. Singh, S. 1962. *Beekeeping in India*. India. ICAR, New Delhi, 214 p.
16. Swan, L. A. 1964. *Beneficial Insects*. Harper and Row London, 429 p.

NEMATOLOGY

1. Nema 3201 Plant parasitic nematodes and their management (1+1)

Theory

Introduction – Position of nematodes in animal kingdom — Importance of nematodes – Brief history and development of Nematology in India – Economic loss in crop plant – Morphology and Anatomy of nematodes (Body wall, digestive, excretory, reproductive and nervous system, sense organs) – Taxonomy of plant parasitic nematodes – Classification of plant parasitic nematodes based on feeding habits – Symptoms of nematode damage – interaction with other microorganisms (fungi, bacteria and viruses) – Biology and ecology of important plant parasitic nematodes (*Meloidogyne, Heterordera, Rotylenchulus, Tylenchulus* and *Radopholus*) – Principles of nematode management (physical methods; cultural methods; host – plant resistance to nematodes; biological control; chemical control) – Major nematode parasites and management in cereals (rice and wheat), millets (sorghum, and maize), pulses (redgram, blackgram, greengram and cowpea),oilseeds (castor and gingelly), vegetables (tomato, brinjal, bhindi, chilli potato, beet root and carrot), fruits (banana, citrus, grapevine and papaya), spices and plantation crops (turmeric, pepper, betelvine and coconut), flower crops (crossandra, jasmine and tuberose), Polyhouse vegetables, Tuber crops (coleus, diascorea, sweet potato).

Practical

Soil and root sampling – Extraction of active nematodes and cysts from soil and roots (Cobb's sieving technique, Baermann funnel technique, Fenwick can method, Incubation and Blender technique) – Nematode processing techniques (preservation, slow and rapid method of processing, making semi permanent and permanent slides) – Morphology of orders *Tylenchida* (*Hoplolaimus*), and *Dorylaimida* (*Xiphinema*) – Identification of important nematodes (*Tylenchorhynchus, Helicotylenchus, Pratylenchus, Hirschmanniella. Hemicriconemoides* / *Criconema Heterodera* / *Globodera, Tylenchulus,* and *Aphelenchoides*) – Life stages of *Meloidogyne*, *Rotylenchulus* and *Radopholus* – symptoms of important nematode diseases – Nematicides and their application

Lecture schedule

1. Introduction- Position of nematodes in animal kingdom — Importance of nematodes – Brief history and development of Nematology in India
2. Brief history and development of Nematology in India and abroad.
3. External morphology of nematode.
4. Anatomy of nematodes- Digestive, excretory and nervous system and sense organs.
5. Anatomy of nematodes - Reproductive system.
6. Taxonomy of plant- parasitic nematodes of the Secernentea and Adenophorea.
7. Classification of plant - parasitic nematodes based on feeding habits
8. Symptoms of nematode damage.
9. Interaction of nematodes with other micro organisms.
   Mid Term Examination
10. &11. Biology and ecology of *Meloidogyne, Heterodera, Tylenchulus, Rotylenchulus* and *Radopholus*.
12. Principles of nematode management (Legislative, physical, cultural, biological and chemical).
13. Integrated nematode management.
14. Nematode parasites of cereals and millets.
15. Nematode parasites of pulses, oilseeds and tuber crops
16. &17 Nematode parasites of vegetables, poly house vegetables and fruit crops.
18. Nematode parasites of spices, plantation crops and flower crops

Practical schedule

1. Soil and root sampling.
2. Extraction of nematodes by Cobb's sieving method. Baermann funnel Technique and modified Baermann funnel technique.
3. Extraction of cysts by conical flask technique and fenwick can method
4. Extraction of nematodes from roots and staining of roots infested with endoparasitic and semi endoparasitic nematodes
5. Preservation of nematodes and preparation of temporary and permanent slides
6. Observing morphology of the order Tylenchida (*Hoplolaimus*) and Dorylaimida (*Xiphinema*, *Longidorus*).
7. Identification of nematodes – *Tylenchorhynchus, Helicotylenchus*.
8. Identification of nematodes – *Pratylenchus, Hirschmanniella*.
9. Identification of nematodes – *Hemicriconemoides – Criconema, Heterodera – Globodera*.
10. Study of life stages of *Meloidogyne*
11. Study of life stages of *Rotylenchulus*.
12. Study of life stages of *Radopholus*.
13. Nematode diseases of rice (White tip and rice root nematode)
14. Damage caused by root – knot and reniform nematodes indifferent crops.
15. Symptoms of damage caused by citrus nematode
16. Symptoms caused by lesion nematode and burrowing nematode of banana.
17. Study of types of nematicides, application methods and calculation of dosages
18. Practical Examination

Suggested Readings

1. Bhatti, D.S. and Walia, R.K. 1992. *Nematode pests of crops.* CBS Publishers and Distributors, Delhi,381p.
2. Gaugler, R. and Kaya, H.K .1990. *Entomopathogenic nematodes in biological control*, CRC Press, Inc., Boca Raton, Florida,632p
3. Goodey, J.B.1963. *Laboratory methods for work with plant and soil nematodes*. Technical Bulletin No.2, Ministry of Agriculture, Fisheries and Food, London,72p.
4. Gopal Swarup and Dasgupta, D.R. 1986. *Plant parasitic nematodes of India – Problems and progress*, ICAR, New Delhi, 76p.
5. Maggenti, A. 1981. *General Nematology*. Springer Verlag, New York Inc., 372p.
6. Nickle, W.R. 1984. *Plant and Insect Nematodes*, Marcel Dekker Inc., New York, 925p.
7. Ravichandra, N.G. 2008. *Plant Nematology*, I.K.International publishing house Pvt Ltd, New Delhi,718p.
8. Reddy, P,P. 1986. *A Treatise on Phyto Nematology*, Agricole Publishing Academy, New Delhi, 381P.
9. Singh, R.S. and K. Sitaramaiah. 1993. *Hand Book of Economic Nematology*, Cosmo Publication, New Delhi, 386p.
10. Thorne, G. 1971. *Principles of nematology*, McGraw Hill Book Co., New York, London, 553p.
11. Webster,J.(Ed.), 1972. *Economic Nematology*, Academic Press, London,.396p.
12. Walia, R. K. and Bajaj, H. K. 2003. *Text book on Introductory Nematology*. ICAR publication, Pusa, New Delhi.

PLANT PATHOLOGY

1. Path 1101 Fundamentals of Plant Pathology (2 + 1)

Theory

Plant pathology- Importance of plant diseases- Definition, Scope - Objectives- History of Plant Pathology-Term and concepts in Plant Pathology- Classification of plant diseases. Important plant pathogenic organisms- Fungi, bacteria, fastidious vascular bacteria, virus,viroids, phytoplasma, spiroplasma, algae, protozoa, nematodes, phanerogamic parasiteswith examples of disease caused by them.Diseases due to abiotic causes. Causes/ factors affecting disease development: disease triangle and tetrahedron.Fungi- definition, characters, somatic structures, nomenclature, classification, key to divisions, sub divisions, orders and classes, reproduction, dispersal. Bacteria, Viruses and mollicutes-Morphology, classification, reproduction, transmission, dispersal and survival. Parasitism, Variability of plant pathogens.Defense mechanism in plants.Pathogenesis. Role in disease development-Enzymes, Toxins, Growth regulators.

Practical

Acquaintance with labequipments and Procedures. Collection and preservation of specimens.Media preparation.Isolation of plant pathogens and proving pathogenicity.Symptoms of fungal bacterial, viral and phytoplasmal diseases.Study of representative fungal genera.Staining and identification of plant pathogenic bacteria.Transmission of plant viruses.Study of phanerogamic parasites.

Lecture schedule

1. Plant Pathology – introduction – importance of plant diseases
2. History of Plant Pathology- International and National importance.
3-4 Causes of plant diseases, Terms and concepts in Plant Pathology– bacteria, fungi, viruses, viroids, phytoplasmas, fastidious vascular bacteria, parasites, pathogens, biotrophs, hemibiotrophs, necrotrophs.
5-6 Pathogenicity, pathogenesis, disease triangle, disease tetrahedron, virulence, infection, inoculum, invasion, colonisation, inoculum potential, symptoms, incubation period.
7-8 Disease cycle, disease syndrome, monocyclic diseases, polycyclic diseases, alternate host, collateral host. Predisposition, physiological race, biotype, symbiosis, mutualism, antagonism
9-10 Defence mechanism in plants
11-12 Pathogenesis- enzymes, toxins and growth regulators in plant disease development
13-14 Types of parasitism and variability in plant pathogens
15-17 Survival and dispersal of plant pathogens
18-19 General characters of fungi, classification of fungi, methods of reproduction

Mid Term Examination

20. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of the Division Myxomycota – *Plasmodiophora, Spongospora.*
21. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of Sub Division MastigomycotinaS*ynchytrium*&*Physoderma*.
22. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of *Pythium*&*Phytophthora*
23. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of *Albugo, Sclerophthora, Peronosclerospora, Peronospora&Plasmopara.*
24. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of Sub Division Zygomycotina. *Rhizopus*and *Mucor.*
25. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of Sub Division Ascomycotina – *Taphrina*&yeasts
26. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of *Erysiphe, Aspergillus, Penicillium*

27. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of *Claviceps, Chaetomium, Ascobolus, Sclerotinia*.
28. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of Sub Division Basidiomycotina. - *Puccinia, Melampsora,Uromyces*.
29. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of *Ustilago, Tilletia, Neovossia, SphacelothecaTolyposporium.*
30. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of Sub Division Deuteromycotina - *Colletotricum, Alternaria, Cercospora, Pestalotia, Botryodiplodiaand Diplodia*.
31. General characters, taxonomy, somatic structures, reproduction, life cycle and plant pathological significance of *Corticium, Fusarium, Helminthosporium, Pyricularia, Sclerotium,Rhizoctonia, Phyllosticta, Phoma, Trichoderma and Verticillium.*
32. Morphological Characters and classification of phytopathogenic bacteria.
33. Symptoms of bacterial diseases, mode of entry, reproduction and spread.
34. Virus – definition nature, properties, classification, virus – vector relationships.
35. Common symptoms of virus, viroid and phytoplasmal diseases of crops.
36. Characters of algal and phanerogamic plant parasites – symptoms.

Practical schedule

1. Common symptoms of plant diseases caused by fungi, bacteria, virus and phytoplasmal diseases
2. Common laboratory equipments and techniques
3. Collection and preservation of plant disease specimen
4. Isolation of plant pathogens and pathogenicity testing
5. Transmission studies for viral disease symptom expression.
6. Microscopic slide culture, common media and mountants used in mycology.
7. Staining and identification of plant pathogenic bacteria
8. Study of characters , symptoms, host parasite relationships and systematic position of fungi belonging to Division Myxomycota.
9. Study of characters,symptoms, host parasite relationships and systematic position of fungi belonging to Sub Division Mastigomycotina*Pythium &Phytophthora.*
10. Study of characters, symptoms, host parasite relationships and systematic position of fungi belonging to White Rust – *Albugo*
11. Study of characters, symptoms, host parasite relationships and systematic position of fungi belonging to Downy mildews – *Plasmopara&Peronospora*
12. Study of characters ,symptoms, host parasite relationships and systematic position of fungi belonging to Sub Division Zygomycotina*Rhizopus*
13. Study of characters ,symptoms, host parasite relationships and systematic position of fungi belonging to Sub Division Ascomycotina. *Aspergillus Penicillum Saccharomyces & Taphrina*
14. Study of characters , symptoms, host parasite relationships and systematic position of fungi belonging to Powdery mildew fungi
15. Study of characters , symptoms, host parasite relationships and systematic position of fungi belonging to Rust Fungi and Smut fungi
16. Study of characters , symptoms, host parasite relationships and systematic position of edible macrofungi andfungi belonging to Sub Division .Deuteromycotina
17. Study of phanerogamic plant parasites.
18. Practical Examination

Suggested Readings

1. Agrios, G.N. 2005. *Plant Pathology*. (5 th 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. Jayaraman, J. and Verma, J. P. 2002.*Fundamentals of Plant Bacteriology* (Reprint, 2015).Kalyani publishers, New Delhi
4. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 1986. *Microbiology*. Tata Mc Graw- Hill Publishing Company Ltd , New Delhi.
5. Ravichandra, N.G. 2013. *Fundamentals of Plant Pathology*.PHILearning Pvt Ltd. 639p.
6. Walkey, D. G. 1991. *Applied Plant Virology* (2nd Ed.). Springer, 352p.
7. Webster, J. and Weber, R. W. S.2007. *Introduction to Fungi*.(3 rd Ed.).Cambridge University press.817 p.

2. Path. 2102 Principles of integrated plant disease management (1+1)

Theory

Categories of diseases; Introduction, history, importance, concepts, principles and tools of IDM; Economic importance of disease risk analysis.Epidemiology: Factors affecting disease development. Methods of detection and diagnosis of diseases.Principles and methods of plant disease management.Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Survey, surveillance and forecasting of diseases. Introduction to conventional fungicides and new generation fungicides for the disease management.Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.Ecological management of crop environment.Development and validation of IDM module.Implementation and impact of IDM (IDM module and disease). Safety issues in pesticide uses. Political, social and legal implications of IDM. Case histories of important IDM programmesin cereals, vegetables, pulses, tuber crops,spices and plantation crops and ornamentals.

Practical

Methods of diagnosis and detection of various plant diseases, Methods plant disease assessment. Assessment of crop yield losses, calculations based on economics of IDM, Identification of biocontrol agents.Mass multiplication of *Trichoderma*, *Pseudomona*s sp. Cultural methods (soil solarization).Physical methods, Planning and implementation of IDM of selected diseases. Nature and damage of important diseases and their management, Assessment of diseases, crop monitoring and planning of preventive strategies, Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations**.** Awareness campaign at farmer's fields.

Lecture schedule

1. Introduction - Losses caused by plant diseases - Importance and history of integrated disease management
2. Epidemiology of crop diseases - Weather, Pathogen and Host factors and their role in crop disease epidemics
3. Survey & surveillance - Disease assessment - Forecasting - Disease modelling - Economic importance of diseases risk analysis.
4. Principles of crop disease management - Importance; General Principles - Avoidance - Exclusion - protection
5. Plant Quarantine and Inspection - Rules and Regulations
6. Cultural control - Roguing, eradication of alternate and collateral hosts, crop rotation, mixed cropping manure and fertilizer management. Sanitation, hot weather ploughing, soil amendments, time of sowing, seed rate and plant density, irrigation and drainage.
7. Physical Methods – soil solarization, heat treatment etc.
8. Biological control - Role and mechanisms of biocontrol agents and PGPR.

Mid Term Examination

9-13. Chemical methods –Fungicides –classification – chemical groups of fungicides – inorganic, organic, systemic, antibiotic etc., Mode of actions - Methods of application of fungicides – seed, soil, foliar spray, post harvest treatment, root feeding etc. - Fungicide formulations – Characteristics of an ideal fungicide. Compatibility and phytotoxicity of fungicides - New generation fungicides.

14. Plant disease resistance – types of resistance – vertical and horizontal – Defense mechanism in plants – Structural and Biochemical (pre and post- infection) cross-protection

15. Biotechnological approach in plant disease management – tissue culture – somaclonal variation, transgenic plants etc.

16. Integrated plant disease management (IDM) – Concepts, advantages and importance. Ecological management of crop environment.

17. Development and validation of IDM module, Implementation and impact of IDM - Political, social and legal implication of IDM.

18. Case studies of important IDM programmesin cereals, vegetables, pulses, tuber crops, spices and plantation crops and ornamentals

Practical schedule

1. Proving Koch's postulates
2. Diagnosis and detection of plant diseases
3. Assessment of diseases – grading, score chart – disease index.
4. Screening of varieties for resistance to plant disease
5. Disease indexing for early detection of virus diseases.
6. Familiarization with different groups of fungicides.
7. Preparation of Bordeaux mixture, Bordeaux paste and cheshunt compound, phytotoxicity of fungicides
8. Preparation of fungicidal spray solutions- methods of application of fungicides – spraying and soil drenching.
9. Seed treatment with systemic and contact fungicides; Root feeding, post harvest treatment.
10. Bio-assay of fungicides – poisoned food technique, inhibition zone technique and slide g ermination technique
11. Bio-control of plant pathogens – dual culture technique and *in- vitro* testing
12. Methods of mass multiplication of *Trichoderma* sp and *Pseudomonas* sp.
13. Solarisation for management of soil borne pathogens; Demonstration of physical methods for crop disease management
14. Preparation and application of botanicals
15. Familiarization with plant protection equipments.
16. Visit to Plant Quarantine Station, Remote sensing laboratory and Tissue culture laboratory
17. Development of IDM of any one disease of field / vegetable / horticultural crops (practical assignment)
18. Practical Examination

Suggested Readings

1. Agrios, G.N. 2005.*Plant Pathology* .Academy Press. New York.
2. Dasgupta, M.K. 1998. *Principles of Plant Pathology*. Allied Publishers Pvt. Ltd. Bangalore
3. Gupta, G.P. 2004. *Text Book of Plant Diseases*.Discovery Publishing House. New Delhi
4. Gupta, V. K. and Sharma, R.C. 2011.*Integrated Disease Management and Plant Health*.Scientific Publishers
5. Maloy,O.C. 1993.*Plant Disease control. Principles and Practice*. John Wiley and Sons.Inc, New York
6. Mehrotra, R.S. 1980. *Plant Pathology* .Tata Mc. Graw Till Publ.Co., , New Delhi.

7. Nene,Y.L. and Thapliyal, P.N. 1998. *Fungicides in Plant Disease Control*. Oxford and IBH New Delhi
8. Prakasam,V., Reguchander,T. and Prabakar,K. 1998. *Plant diseases management*. A.E. Publication, Coimbatore.
9. Singh. R.S. 2002. *Introduction to Principles of Plant Pathology*. Oxford and IBH Publishing, New Delhi.

3. Path.2203 Diseases of crops and their management I (2+1)

Theory

Symptoms, etiology, disease cycle and management of major diseases of following crops: Field crops Rice: blast, brown spot, bacterial blight, sheath blight, sheath rot, foot rot, false smut, khaira and tungro;

Maize: stalk rots, downy mildew, powdery mildew, leaf spots, rust; Sorghum: smuts, grain mold and anthracnose, downy mildew, powdery mildew, rust, leaf spots; Bajra: downy mildew and ergot; powdery mildew, leaf spots, rust; Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and ear cockle; Finger millet: Blast and leaf spot; Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and PokkahBoeng; Cotton: anthracnose, vascular wilt, and black arm; Tobacco: damping off, black shank, black root rot and mosaic, leaf curl; Groundnut: early and late leaf spots, root rot, viral diseases, wilt; Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Sunflower:Sclerotinia stem rot and Alternaria blight; Castor: Phytophthora blight; Pea: downy mildew, powdery mildew and rust; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Vegetable Crops:Cruciferous vegetables: Club root, Alternaria leaf spot, black rot, damping off, downy mildew, black leg, black rot, head rot and leaf blight; Mustard:Alternaria blight, white rust, downy mildew and Sclerotinia stem rot; Potato: late blight, early blight, wart, black scurf, bacterial wilt, viral diseases; 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; Chillies: anthracnose and fruit rot, wilt and leaf curl, mosaic; Okra: Leaf spot, Yellow Vein Mosaic; Beans: Anthracnose and bacterial blight; Tapioca: leaf spot, sett rot, tuber rot, bacterial wilt, mosaic; Colocasia, Yams, Amorphophallus:Phytophthora blight; Cucurbits: downy mildew, powdery mildew, wilt, leaf spot, viral diseases; Onion and garlic: purple blotch, and Stemphylium blight; Amaranthus& leafy vegetables: white rust, leaf blight; Coriander: stem gall; Post harvest diseases in field and vegetable crops etc.

Practical

Identification and histopathological studies of selected diseases of field and vegetable 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.

Lecture schedule

1. Introduction to the study of crop diseases – economic importance of crop diseases- symptoms - causal agents - disease cycle – management.
2. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Rice- blast, sheath blight, sheath rot.
3. Economic importance, symptoms, causal organisms, epidemiology and management of other diseases of Rice - brown spot, false smut, udbatta , foot rot etc.

4. Bacterial diseases of Rice –Bacterial Leaf Blight and bacterial leaf streak;Viral and phytoplasmal diseases-tungro, grassy stunt, yellow dwarf and ragged stunt ;mineral deficiency diseases.
5. Economic importance, symptoms, causal organisms, epidemiology and management of Wheat rusts.
6. Economic importance, symptoms, causal organisms, epidemiology and management of smuts and bunts, powdery mildew, Alternaria leaf blight, and tundu of Wheat.
7. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of millets - Sorghum- rusts, smuts, downy mildew, sugary disease, charcoal rot, anthracnose, blight, leaf spot and striga.
8. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Maize- smuts, downy mildew, rust, stalk rot and leaf spot.
9. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Bajra- rusts, smuts, downy mildew and ergot.
10. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of minor millets.
11. Diseases of legumes -economic importance, symptoms, causal organisms, epidemiology and management of diseases of Pigeon pea – Phytophthora blight, wilt, sterility mosaic and dry root rot.
12. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Red, Black, Green and Bengal gram - Dry root rot, rust and mosaic; gram – wilt, grey mold and Ascochyta blight; lentil – rust and wilt.
13. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of oil seeds - Groundnut- early and late leaf spot, rust, Sclerotium stem rot, aflaroot disease.
14. Economic importance, symptoms, causal organisms, epidemiology and management of Groundnut - crown rot, seedling rot, seedling blight, pod rot and viral diseases.
15. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of diseases of Sunflower – Sclerotium stem rot, rust, Alternaria blight and head rot.
16. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Sesamum - leaf spots and leaf blights, powdery mildew and phyllody.
17. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Castor – seedling blight; Mustard – white rust, downy mildew, Sclerotium stem rot, Alternaria blight and bacterial rot.
18. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Soybean- Rhizoctonia blight, pod blight, seed rot, bacterial pustule, seedling blight and mosaic.

Mid Term Examination

19. Economic importance, symptoms, causal organisms, epidemiology and management of fungal diseases of Sugarcane – red rot, whip smut, wilt and pineapple disease.
20. Economic importance, symptoms, causal organisms, epidemiology and management of Sugarcane - ratoon stunting, grassy shoot, gummosis and other bacterial diseases.
21. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Cotton - wilt, root rot, anthracnose, grey mildew, black arm and leaf curl.
22. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Tobacco – damping off, black shank, frog eye spot and wild fire.
23. Economic importance, symptoms, causal organisms, epidemiology and management of fungal diseases of Potato – late blight, early blight, wart, black scurf etc.
24. Economic importance, symptoms, causal organisms, epidemiology and management of Potato - brown rot and other bacterial diseases.
25. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Potato viral diseases.

26. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Brinjal - Phomopsis blight and fruit rot, Sclerotiniablight, bacterial wilt, and phyllody.
27. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Chillies – anthracnose, damping off, bacterial and viral diseases.
28. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Bhindi – leaf spot, powdery mildew and yellow vein mosaic.
29. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Tomato- damping off, late blight, early blight, fruit rot, fungal and bacterial wilt, viral and phytoplasmal diseases.
30. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Cucurbits – damping off, downy mildew, powdery mildew, anthracnose, and fruit rot, wilt, viral and phytoplasmal diseases.
31. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Cowpea and Beans – collar rot and web blight, Fusarium wilt, rust, powdery mildew, anthracnose and Sclerotium blight.
32. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Crucifers - damping off, downy mildew, black leg, black rot, head rot and leaf blight.
33. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of onion- smut, smudge, Alternaria blight, anthracnose; leafy vegetables / amaranthus –white rust and Rhizoctonia leaf blight.
34. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Tuber crops – Cassava – mosaic, bacterial wilt, leaf spots, sett rot, tuber rot.
35. Economic importance, symptoms, causal organisms, epidemiology and management of diseases of Sweet potato&other tuber crops – wilt and viral disease complex.
36. Post harvest diseases in vegetables and field crops.

Practical schedule

1. Field visits, survey and collection of disease samples.
2. Preservation of disease specimens.
3-4. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of rice.
5. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of wheat.
6. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of sorghum and maize.
7. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of bajra and other millets.
8. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of groundnut, sunflower and sesamum.
9. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of castor, mustard and soybean.
10. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of redgram, greengram, blackgram, bengalgram, beans and vegetable cowpea.
11. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of cotton.
12. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of tobacco.
13. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of potato.
14. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of solanaceous vegetables.

15. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of bhindi and amaranthus.
16. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of Crucifers and Cucurbits..
17. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of Tuber crops and tea.
18. Practical Examination

Note: Collection and preservation of plant diseased specimens for Herbarium. Students should submit 50 pressed and well-mounted specimens.

Suggested Readings

1. Agrios, G.N. 2005. *Plant Pathology*.Academy Press. New York.
2. Gupta, G.P. 2004. *Text Book of Plant Diseases*. Discovery Publishing House. New Delhi
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4. Koike. S.T., Gladders, P. and Paulus,O. A.2006. *Vegetable Diseases - A Color Handbook*. Academy Press. New York.
5. Mehrotra, R.S. 1980. *Plant Pathology*.Tata Mc. GrawHill Publ.Co., New Delhi.
6. Nair, M.C. and Menon , M.R. 1985. *Diseases of Crop Plants in Kerala*. Kerala Agricultural University
7. Peethambaran, C.K., Girija, V.K., Umamaheswaran, K, and Gokulapalan,C. 2008. *Diseases of Crop plants and their management*.Kerala Agricultural University.
8. Prakasam, V. Valluvaparidasan.V., Raguchander, T., Prabhakar, K. and Thiruvudainambi.S 1997.*Field Crop Diseases*, A.E publication, Coimbatore.
9. Ramakrishnan, T. S. 1971. *Diseases of Millets*.Indian Council of Agricultural Research.
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12. Rivka Barkai-Golan. 2001. *Postharvest Diseases of Fruits and Vegetables: Development and Control*. Elsevier B.V. USA.
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14. Singh, R. S. 1995. *Diseases of Vegetables Crops*.Oxford and IBH Publishing Co.
15. Singh, R.S. 1990. *Plant Diseases*. Oxford & IBH Publishing Company
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4. Path.3104 Diseases of crops and their management II (2+1)

Theory

Symptoms, etiology, disease cycle and management of following diseases: Coconut: wilt and bud rot; Root (wilt), bud rot, leaf rot, grey leaf blight, Foot rot, stem bleeding, cadangcadang disease, lethal yellowing; Arecanut: Mahali, foot rot, Stem bleeding, inflorescence die back, yellow leaf disease, nursery diseases, nutritional disorders, Oil palm: nursery diseases, crown diseases, root and trunk diseases, bud rot, sudden wilt; Cocoa- black pod rot, Monilia pod rot, Botryodiplodia pod rot, other pod rot diseases, Cushion gall disease, witches broom, wilts, root disease , cherelle wilt , swollen shoot; Rubber: Abnormal leaf fall, powdery mildew, stem diseases, root diseases; Tea -Blister blight, grey blight, thread blight, brown blight, birds eye spot stem and root diseases; Coffee: rust, leaf spots, coffee berry diseases, root and stem diseases, die back; Cardamom:azhukal/ capsule rot and clump rot, Katte and other viral disease, other foliar diseases, nursery diseases; Black pepper: foot rot, slow wilt, pollu disease, bacterial leaf spot ,viral and phytoplasmal diseases; Betel vine: foot rot, anthracnose, bacterial leaf spot; Ginger: soft rot, leaf spot, thread blight and bacterial wilt; Turmeric:

leaf blotch, leaf spot, rhizome rot and root rot; Clove: slow decline, root diseases, leaf blight, die back, leaf spot diseases, leaf blotch; Cinnamon: leaf blight, leaf spot, leaf blotch and die-back symptoms, root diseases; Nutmeg and vanilla: leaf spots, fruit rot and root diseases.Banana: Panama wilt, Moko wilt; Viral diseases-Bunchy top, Mosaic, heart rot, infectious chlorosis and Kokkan, postharvest diseases; Mango: malformation, anthracnose, powdery mildew, die back, pink disease, sooty mould, red rust, black tip; deficiency diseases; post-harvest diseases; Cashew: powdery mildew, anthracnose, damping off, pink disease, sooty mould and inflorescence blight; Grapevine- downy mildew , powdery mildew, anthracnose, black rot, foot rot, dead arm, rust, bacterial viral and phytoplasmal diseases; Citrus: gummosis, leaf fall and fruit rot, scab, pink disease, powdery mildew, root rot , felt disease, sooty mould, citrus canker, tristeza, greening and exocortis, post harvest diseases; Pineapple- fruit rot/ basal rot/heart rot, wilt and leaf spot; Jack: pink disease, immature fruit rot and post harvest diseases; Papaya: stem/foot rot, leaf spot, mosaic, leaf curl, post- harvest diseases; Pomegranate: foliage, stem, fruit and root diseases; Sapota: leaf spot, flat limb, fruit rot; Guava: wilt, canker, dry rot, leaf spot, seedling blight, post harvest diseases; Mulberry-foliar diseases, stem and root diseases; Apple: scab, powdery mildew, root rot, collar rot, black rot, fire blight, mosaic, post harvest and non parasitic diseases; Rose - black spot, powdery mildew, rust, dieback, blight, leaf spot, anthracnose, bacterial leaf spot and viral diseases; Foliar and flower diseases of Orchids, Anthurium, Dahlia, Chrysanthemum & Jasmine.

Practical

Identification and histopathological studies of selected diseases of 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.

Lecture schedule

1. Introduction to the study of diseases of horticultural crops, economic importance, symptoms, causal agents, disease cycle, management.
2. Diseases of coconut, Root (wilt) disease, economic importance, distribution and symptoms on crown and roots, etiology, disease cycle and integrated management of Root (wilt) disease of coconut.
3. Economic importance, symptoms, cause, disease cycle and integrated management of bud rot, leaf rot, grey leaf blight of coconut.
4. Economic importance, symptoms, cause, disease cycle and integrated management of Foot rot and stem bleeding, cadangcadang disease, lethal yellowing and other diseases of unknown etiology of coconut.
5. Economic importance, symptoms, cause, disease cycle and integrated management ofdiseases ofarecanut- Mahali, foot rot, Stem bleeding, inflorescence die back.
6. Economic importance, symptoms, cause, disease cycle and integrated management of yellow leaf disease of arecanut, nursery diseases, stem breaking.
7. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of oil palm, nursery diseases, crown diseases, root and trunk diseases, bud rot, sudden wilt and other diseases of oil palm.
8. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of cocoa- black pod rot, Monilia pod rot, Botryodiplodia pod rot, other pod rot diseases.
9. Economic importance, symptoms, cause, disease cycle and integrated management of Cushion gall disease, witches broom, wilts, root disease, cherellewilt , swollen shoot of cocoa.
10. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of rubber -Abnormal leaf fall, powdery mildew, stem diseases, root diseases.
11. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of tea -Blister blight, grey blight, stem and root diseases.
12. Economic importance, symptoms, cause, disease cycle and integrated management of Thread blight, brown blight ,birds eye spot of tea.

13. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of coffee - foliar diseases -rust and leaf spots.
14. Economic importance, symptoms, cause, disease cycle and integrated management of coffee berry diseases, root and stem diseases, die back.
15. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of cardamom- azhukal/ capsule rot and clump rot.
16. Economic importance, symptoms, cause, disease cycle, transmission and integrated management ofKatte and other viral disease ,other foliar diseases,Nursery diseases.
17. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of black pepper- foot rot and slow wilt.
18. Economic importance, symptoms, cause, disease cycle and integrated management of Polludisease , bacterial leaf spot ,viral and phytoplasmal diseases.

Mid Term Examination

19. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of betel vine- foot rot, anthracnose, bacterial leaf spot.
20. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of ginger - soft rot, leaf spot, thread blight and bacterial wilt.
21. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of turmeric, leaf blotch, leaf spot, Rhizome rot and root rot.
22. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of clove - slow decline, root diseases, leaf blight, die back, leaf spot diseases, leaf blotch
23. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of cinnamon - leaf blight, leaf spot, leaf blotch and die-back symptoms, root diseases.
24. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of nutmeg andvanilla - leaf spots, fruit rot and root diseases.
25. Economic importance, symptoms, cause, disease cycle and integrated management of wilt diseases of banana- Panama wilt, Moko wilt; Viral diseases-Bunchy top, Mosaic, heart rot, infectious chlorosis and Kokkan
26. Economic importance, symptoms, cause, disease cycle and integrated management ofpost harvest diseases - Anthracnose, crown rot, black spot, pitting diseases, cigar end rot and pink mould rot.
27. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of mango- mango malformation, anthracnose, powdery mildew, die back, pink disease, sooty mould, red rust, black tip; deficiency diseases; post-harvest diseases - Diplodia stem end rot, anthracnose, soft rot, Black mould rot and Alternaria rot.
28. Economic importance, symptoms, cause, disease cycle and integrated management ofdiseases of cashew - powdery mildew, anthracnose, damping off, pink disease, sooty mould and inflorescence blight.
29. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of grapevine- downy mildew , powdery mildew, anthracnose, black rot, foot rot, dead arm, rust, bacterial viral and phytoplasmal diseases.
30. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of citrus-gummosis, leaf fall and fruit rot, scab, pink disease, powdery mildew, root rot , felt disease, sooty mould, citrus canker, tristeza, greening and exocortis, post harvest diseases.
31. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of pineapple- fruit rot/ basal rot/heart rot, wilt and leaf spot; diseases of jack-pink disease, immature fruit rot and post harvest diseases.
32. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of papaya- stem/foot rot, leaf spot, mosaic, leaf curl, post- harvest diseases. Diseases of pomegranate and ber - foliage, stem, fruit and root diseases.

33. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of sapota- leaf spot, flat limb, fruit rot; Diseases of guava, wilt, canker, dry rot, leaf spot, seedling blight, post harvest diseases.
34. Diseases of mulberry-foliar diseases, stem and root diseases. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of apple-scab, powdery mildew, root rot, collar rot, black rot, fire blight, mosaic, post harvest and non parasitic diseases.
35. Diseases of rose - black spot, powdery mildew, rust, dieback, blight, leaf spot, anthracnose, bacterial leaf spot and viral diseases.
36. Diseases of orchids and anthurium. Economic importance, symptoms, cause, disease cycle and integrated management of diseases of dahlia, chrysanthemum & jasmine.

Practical schedule

1. Field visits, survey and collection of disease samples
2. Preservation of disease specimens
3-4. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of coconut
5. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of arecanutand oil palm
6. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of cocoa
7. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of rubber
8. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of tea and coffee
9. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of cardamom
10. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases ofblack pepper, betelvine
11. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of ginger, turmeric
12. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of tree spices and vanilla.
13. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of Banana
14. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of mango and cashew
15. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of sapota, jack, pomegranate and ber.
16. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of grapevine citrus, pineapple, papaya
17. Study of symptoms, etiology, host-parasite relationship and specific control measures of diseases of, apple,mulberry, rose, orchids and anthurium, dahlia, chrysanthemum & jasmine
18. Practical Examination

Note: Collection and preservation of plant diseased specimens for Herbarium. Students should submit 50 pressed and well-mounted specimens.

Suggested Readings

1. Agrios, G.N. 2005. *Plant Pathology.*Academy Press. New York.
2. Bavappa. K.V.A., Nair M. K. and Premkumar, T. 1978. *The Arecanut palm*. CPCRI, Kasargod.

Elsevier B.V. USA.

3. Golan, B.R. 2001. *Postharvest Diseases of Fruits and Vegetables: Development and Control.*

4. Gupta, G.P. 2004. *Text Book of Plant Diseases*. Discovery Publishing House. New Delhi

International Pvt Ltd. New Delhi.

Lucknow.

5. Mehrotra, R.S. 1980. *Plant Pathology*.Tata Mc. GrawTillPubl.Co., New Delhi.

6. Nair, M. C. and Menon, M. R. 1983. *Disease of crop plants of Kerala*, Kerala Agricultural University Press, Mannuthy.

7. Pathak, V.N. 1980. *Diseases of fruit crops*. Oxford and IBH, New Delhi.

8. Peethambaran, C.K., Girija, V.K., Umamaheswaran, K. and Gokulapalan,C.2008. Diseases of Crop plants and their management.Kerala Agricultural University.

9. Ploetx, R.C. 2004.Diseases of tropical fruit crops.CAB eBooks.Ebooks on agriculture and the applied life sciences from CAB International

10. Rangaswami.G. 1987..Diseases of Crop plants in India.Prentice Hall of India Private Ltd. New Delhi.

11. Sanjeev Kumar. 2015. Diseases of Horticultural Crops Identification and Management. Astral

12. Santhakumari, P. (ed) 2004. *Advances in Diseases of Plantation crops and Spices*. IDB Co.,

13. Sharma, P. D. 2001. *Plant Pathology*.Rastogi publications, Shivaji Road, Meerut.

14. Sharma, Y. R and Premkumar, T. 1991. *Diseases of black pepper*.NRC for spices, Calicut.

15. Singh, R.S. 1990. *Plant Diseases.* Oxford & IBH Publishing Company

16. Verma, L. R. and Sharma, R.C.1999.*Diseases of Horticultural Crops*: Fruits. Indus Publishing. New Delhi.

PLANT PHYSIOLOGY

1. Crps 1201 Fundamentals of Crop Physiology (2+1)

Theory

Introduction to crop physiology and its importance in agriculture; Plant cell- an overview- Structure and functions of cell organelles; Crop water relations, water potential and its components, diffusion and osmosis, absorption of water; Transpiration and stomatal physiology, water use efficiency. Mineral nutrition of plants- functions and deficiency symptoms of nutrients– nutrient uptake mechanisms- foliar nutrition and hydroponics. Photosynthesis - Light and dark reactions C_3, C_4 and CAM plants, photorespiration: Plant respiration- glycolysis, TCA cycle and Electron transport chain, Alternate respiration in plants; Plant growth regulators – physiological roles and agricultural uses; Physiological aspects of growth and development of major crops; Photoperiodism and vernalisation; Growth analysis, role of physiological growth parameters in crop productivity.

Practical

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; Photosyntheisis, respiration, tissue test for mineral nutrients; estimation of RWC; Measurement of rate of photosynthesis by IRGA; Estimation of hormone using bioassay.

Lecture schedule

1. Introduction to crop physiology and its importance in agriculture;
2 and 3. Structure and physiological functions of cell and cell organelles; cell wall, cell membrane, cell inclusions, cytoskeleton
4. Crop water relations, water potential and its components, Diffusion, osmosis.
5. Diffusion, osmosis; Mechanism of water absorption
6. Transpiration, significance, transpiration in relation to crop productivity, anti-transparents, water use efficiency
7. Stomata, structure and function- mechanism of stomatal movements
8. Water stress- drought tolerance mechanisms
9. Nutrio-physiology – definition – classification of plant nutrients based on quantity, function and mobility
10, 11 Nutrient absorption mechanism- foliar nutrition and hydroponics
12. Functions of plant nutrients – deficiency and toxicity symptoms of plant nutrients
13. Photosynthetic pigments
14. Photosynthesis-Light reactions-Photosynthetic electron transport chain
15. Rubisco- Calvin cycle
16. C_4 and CAM mechanisms
17. Photorespiration-Significance
18. Respiration and its significance

Mid Term Examination

19. Glycolysis- TCA cycle
20. Mitochondrial ETC, Alternate respiration
21-24 Plant growth regulators- biosynthesis and physiological role of auxin, gibberellins, cytokinin, ABA, ethylene
25. Novel PGRs and commercial applications in agriculture

26, 27, 28, 29 Physiological aspects of growth and development- Rice, Coconut, Cassava, Black pepper, Banana

30, 31 Physiology of flowering-Photoperiodism and vernalisation in relation to crop productivity, Photoreceptors

32- 34 Growth analysis, measurement of growth, role of physiological growth parameters in crop productivity-RGR, CGR, NAR, LAI, SLA, HI

35. Physiological disorders in crop plants

36. Recent developments in plant physiology

Practical schedule

1. Preparation of standard solutions; Safe laboratory practices
2. Study of plant cells
3. Isolation of chloroplast and mitochondria
4. Structure and distribution of stomata
5. Demonstration of diffusion and imbibition
6. Demonstration of osmosis
7. Demonstration of Plasmolysis
8. Demonstration of root pressure
9. Measurement of transpiration rate
10. Separation of photosynthetic pigments
11. Estimation of chlorophyll pigments
12. Measurement of Photosynthetic rate by IRGA
13. Measurement of respiration
14. Tissue test for mineral nutrients
15. Estimation of RWC
16. Growth analysis
17. Estimation of hormone using bioassay,Measurement of leaf area
18. Practical Examination

Suggested Readings

1. Devlin, R. M. and Witham F. H. 1983. *Plant Physiology* 4th Ed. CBS Publishers and Distributors, New Delhi.
2. Devlin, R.M. 1979. *Plant Physiolgoy* II Ed. Affiliated East West Press, New Delhi
3. Gupta, N.K. and Sunita Gupta. 2002. *Plant Physiology*. Oxford & IBH Publishing Co.Pvt.Ltd.NewDelhi.
4. Malick ,C.P. and Srivastava, A.K.2000.*Text book of Plant Physiology*. Kalyani publishers,New Delhi.
5. Milthrope, F.L. and Marby, J. 1979. *An introduction to Crop Physiology*. Cambridge University Press, London
6. Noggle, G.R. and Fritz, G.J. 1992. *Introductory Plant Physiology* II Ed. Prentice Hill of India (P) Ltd., New Delhi
7. Salisburry, F. B. and Ross, C.W. *Plant Physiology*, CBS Publishers & Distributors, New Delhi
8. Taiz, Land Zeiger, E. 2014. *Plant Physiology*. Sinauer Associates, Inc., Publishers.

AGRICULTURAL STATISTICS

1. Stat 2101 Agri-Informatics(1+1)

Theory

Introduction to Computers, Input and Output Devices. Units of Memory, Hardware, Software and Classification of Computers - Types of Processors, Computer Virus, Worms and Vaccines. Operating System - DOS, WINDOWS. UNIX and open softwares. Application of MS-Office for document creation and editing.Word Processing packages, Features of Word Processing. Electronic Spreadsheets, Concept, Packages. Creating, Editing and Saving a Spreadsheet. Use of in-built Statistical and other functions and writing mathematical expressions.Statistical Data analysis tools, Creating Graphs. Concept of Database and Information management - Units of Database, Creating Database. Extracting results from database.

Presentation packages, Features of presentation. World Wide Web (WWW): Concepts and components. Basics of Programming languages.Communication tools - Internet and applications - E-learning, E-Journals, E-Agriculture, and its applications. Smart phone applications in agriculture for farm advices, market price, post harvest management etc.Geospatial technology for generating valuable agri- information.Decision support systems - concepts, Agriculture Expert System - Components and Applications in Agriculture.

Practical

Computer Components - Booting of Computer and its Shut Down. Practice of some fundamental DOS Commands and other operating systems. Creating Folders, COPY and PASTE functions.Creating a Document - Saving and Editing. Different types of options from Tool Bars, Format, Spelling and Grammar checking, Alignment of text. Creating tables.Creating Spreadsheets - Alignment of Rows, Columns and Cells using Format Tool Bar. Entering Expressions through the Formula Tool Bar and use of Inbuilt Functions, Statistical functions - Data Analysis using Inbuilt Tool Packs, Correlation and Regression.Creating Graphs Creating Database, Structuring with different types of fields.Developing queries and related files.Preparation of Slides for presentation. Crop Simulation Models (CSM) using standard softwares.Introduction of geospatial technology for generating valuable information for agriculture.Applications of Decision Support System and Expert System in Agriculture.

Lecture schedule

1. Introduction to computers - characteristics of computers - evolution of computers - generations of computers.
2. Hardware and software - classification of computers - personal computers - software. categories - system software and application software - Input and output units - central processing unit - types of processors - memory - primary and secondary memory - RAM and ROM.
3. Operating system - DOS and WINDOWS - fundamental DOS commands - FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD, CD, DEL and TREE.
4. Rules for naming files in WINDOWS: GUI, Desktop and its elements - creating folders - WINDOWS Explorer - Anatomy of WINDOW - Title bar - Minimum and close buttons - scroll bars - menus and tool bars.

5-6. Number systems - binary and decimal - conversion between number bases.

7. Word processing - Word processing packages - features - Document - units of document Menus - Creating, editing, formatting and saving documents.
8. Word processing packages - copy, cut and paste functions - creating tables - merging of cells - column and row width.
9. Electronic Spreadsheets - concept - Spreadsheet packages - worksheet and workbook - creating, editing and saving a workbook.

Mid Term Examination

10-11 Electronic Spreadsheets - alignment of rows, columns and cells using Format toolbar - Entering a formula in a cell. Statistical functions - SUM, AVERAGES, VARIANCE, MAX, MIN, IF. Data Analysis - regression, correlation, frequency distribution, t-test - Creating graphs and charts.

12- Concept of database and Information management - units of database - creating database

13.

14. Presentation softwares - preparation of slides.

15. World Wide Web (WWW): Concepts and components. Principles of programming - flowcharts and algorithms.

16. Programming languages - low level and high level languages.

17. Smart phone applications in agriculture for farm advices, market price, post harvest management etc. Geospatial technology for generating valuable agri - information.

18. Decision support system and Expert system - Concepts and their applications in agriculture.

Practical schedule

1. Study of computer components - booting and shut down of computer - practice of DOS commands - TIME, DATE, DIR, COPY, LABEL, VOL, MD, CD, RD, DEL.

2. Practicing other Operating systems - Using mouse - Title bar - Minimum, Maximum and Close buttons, Scroll bars, menus and toolbars

3. Desktop - icons - creating folders - COPY and PASTE functions, Windows Explorer

4-6. Word processing packages - creating and saving a document - editing and formatting a document- Use of options from Toll bars - Format, Insert , Tools copy , cut and paste functions - creating tables - merging of cells - column and row and width.

7-9. Electronic Spreadsheets - creating , editing and saving a workbook - alignment of rows, columns and cells using Format toolbar - Entering a formula in a cell, statistical functions - SUM, AVERAGE, VARIANCE, MAX, MIN, IF - Data Analysis - regression, correlation, frequency distribution, t-test. Creating graphs and charts

10-12. Database management packages- creating database- structuring with different types. Records - fields - tables - queries

13. Presentation software - preparation of slides on PowerPoint.

14-15. Practical applications of Crop Simulation Models (CSM) using standard softwares.

16-17. Uses of Geospatial technology for generating valuable information for Agriculture, practical uses of model Decision Support System and Expert System in Agriculture

18. Practical Examination

Suggested Readings

1. Balaguruswamy, E. 1998. *Programming with ANSI - C*. Tata Mc Graw Hill, New Delhi.
2. Capron, H.L. 1996. *Computers tool for an information age*: Benjamin/ Cummings Publishing Company, Inc. New York
3. Date, C.J. 2000. *Introduction to Database System*. Addison Wesley
4. Gottfried, B. 1999. *Programming with C, Schaum Outline Series*. Tata McGraw Hill.
5. Malvino, A.P. and Brown, J.A. 1999. *Digital Computer Electronics*. Tata McGraw Hill.
6. Nortons, P. 2001. *Introduction to computers*, 4th Ed,Tata Mc Graw Hill, New Delhi
7. Parekh R. 2006. *Principles of Multimedia*. Tata McGraw-Hill.
8. Rob, P. and Coronel, C. 2006. *Database Systems: Design, Implementation and Management*. 7th Ed. Thomson Learning.
9. Silberschartz, A., Korth, H.F. and Sudarshan, S. 1997. *Database Systems Concepts*. Tata McGraw Hill
10. Vaughan, T. 2003. *Multimedia-Making it Work*. McGraw-Hill.

2. Stat 3202 - Statistical methods and applications (2+1)

Theory

Introduction: Definition of Statistics - its uses and limitations, Functions of Statistics, Collection of statistical data. Frequency distributions-. Diagrammatic and graphical presentation of statistical data. Measures of central tendency:. Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean. Comparisons of these averages and the selection of appropriate average. Properties of Arithmetic mean. Weighted Arithmetic mean. Measures of Dispersion: definition.. Range, Quartile deviation, Mean deviation and Standard deviation. Relative measures of dispersion – Coefficient of variation. Skewness, Kurtosis and its measures. Correlation. scatter diagram. Correlation coefficient. Rank correlation coefficient.. Regression. Linear regression and its applications in agriculture, Interpretation of Regression coefficient. Correlation *vs*. Regression. Probability: Definition and concept of Probability, Addition, and Multiplication theorems on Probability (without proof). Binomial, Poisson and Normal Distributions. Introduction to Sampling- Sampling distributions and Standard error. Sample Surveys in Agriculture. Simple random sampling with and without replacement. Definition of Hypothesis - Tests of statistical hypothesis. Type I and II Errors. Steps involved in Testing of Hypothesis. Level of Significance and Degrees of freedom. Critical Region, Large Sample Tests – Z transformation of the Correlation Coefficient. Small sample tests- Tests for equality of means and variances – **t** and **F** tests. Paired **t** test. Tests of significance of correlation coefficient. Chi- square tests – Assumptions, limitations and applications. Contingency table – Yates' correction for continuity. Design of experiments. Need for designing experiments – Basic principles of experimentation. Practical considerations in field experimentation- Size and shape of plots and blocks, Border effects. Methods of analysis of data from designed experiments. Analysis of Variance, assumptions, Transformation of data, Post hoc tests. One, two and three way classifications. Completely Randomised Design: Layout and analysis, advantages and limitations. Randomised Block Design: Layout and analysis, advantages and limitations. Latin Square Design: Layout and analysis.

Practical

Calculation of various measures of central tendency,computation of various measures of dispersion viz. coefficients of variation,skewness and kurtosis,computation of product moment correlation coefficient and rank correlation,fitting of Linear regression models for prediction,simple problems on probability,fitting of binominal distribution,problems on Poisson distribution,applications of Normal distributions in agriculture,selection of simple random sample,estimation of parameters,sample size determination,large and small sample tests,tests on correlation coefficients,test for equality two small sample variances, F test, ***t*** test for equality of means with equal variance, means with unequal variances, Cochran and Cox tests,Paired ***t*** test, Chi-square tests of goodness of fit , Tests of independence of attributes in a contingency table,analysis of one way and two way classified data,layout and analysis CRD and RBD,layout and analysis LSD,transformations of data

Lecture schedule

1. Introduction – Definition, collection and classification of data , Formation of frequency distribution. Diagrammatic and graphical presentation of statistical data.
2. Measures of central tendency - Arithmetic mean- its properties- weighted arithmetic mean- geometric and harmonic mean.
3. Median and other measures of location- Formula for calculation-merits and demerits – comparison of different averages.
4. Measures of dispersion- Calculation of range-mean deviation –quartile deviation.

5-6. Standard deviation and variance- comparisons among different measures of dispersion – relative measures of dispersion – coefficient of variation

7. Measures of skewness and kurtosis.

8-9. Presentation of bi-variate data – scatter diagram – measures of association –product moment correlation, Rank correlation

10. Linear regression – its application in agriculture – regression equations – correlation *vs*. regression.

11. Elementary ideas on probability – Addition and multiplication theorems on probability (without proof)

12-13. Binominal and Poisson distributions – fitting of binominal and Poisson distributions

14-15. Normal distribution- its importance in statistics –problems based on Normal probability integral.

16-18. Sample surveys in agriculture- Sampling- advantages of sampling over census method-Simple random sampling- with and without replacement – standard error– selection of samples – sample size, estimation of sample mean, variance and standard error of sample mean.

Mid Term Examination

19-20. Tests of statistical hypotheses- null hypothesis and alternative hypothesis, type I and Type II error, level of significance -critical region

21- 23 Large sample tests- test for proportions, test for means and test for standard deviations - ***Z*** -transformation of the correlation coefficient and test of significance between correlation coefficients

24-25 Small sample tests- Tests for equality of means and variances- t-and ***F*** test- test of significance of correlation coefficient and paired t-test

26 Chi-square tests- application of chi-square tests- Yates' correction for continuity.

27-28. Design of experiments- Introduction –Important terms and definitions –Need for designing an Experiment. Basic principles of experimentation – replication, randomization and local control.

29. Practical considerations in field experiments - coping with soil heterogeneity –size and shape of plots and blocks –border effect –uniformity trials and their uses.

30-31. Analysis of variance- assumptions –Construction of ANOVA table- Data that violate assumptions of the analysis of variance. Transformations of data

32-33. One, two and three way classifications -conclusions based on means-critical difference.

34. Completely Randomized Design –Lay out, analysis, advantages and limitations

35. Randomized Block Design – Layout, analysis, choice of number of blocks, advantages and limitations.

36. Latin square designs-layout, analysis, applications, advantages and limitations

Practical schedule

1. Calculation of various measures of central tendency.
2. Computation of various measures of dispersion - coefficients of variation- skewness and kurtosis.
3. Computation of product moment correlation coefficient and rank correlation
4. Fitting of Linear regression models for prediction.
5. Simple problems on probability – fitting of binominal distribution
6. Problems on Poisson distribution - Applications of Normal distributions in agriculture.

7-8. Selection of simple random sample –estimation of parameters –sample size determination.

9-10. Large and small sample tests- Tests on correlation coefficients.

10-11 Test for equality two small sample variances- F test, ***t*** test for equality of means with equal variance, means with unequal variances – Cochran and Cox tests, Paired ***t*** test

12-13. Chi-square tests of goodness of fit, Tests of independence of attributes in a contingency table

14. Analysis of one way and two way classified data

15-16 Layout and analysis CRD and RBD

12. Layout and analysis LSD,transformations of data

13. Practical Examination

Suggested Readings

1. Cochran,W.G.1989. *Sampling Techniques* , Oxford and IBH Publishing Co.
2. Cox, D.R. 1958. *Planning of Experiments*, Wiley, New York
3. Das, M.N. and Giri, V.V. 2011. *Design and Analysis of Experiments*, New Age International Publishers, Daryaganj- New Delhi-110 002
4. Federer, W.T. 1967. *Experimental Design*, Oxford and IBH Publishing Company, New Delhi.
5. Fisher, R.A. 1947. *Design of Experiments*, Oliver and Boyd, Edinburgh, London.
6. Gomez, K.A. and Gomez, A.A.1984. *Statistical procedures for Agricultural Research* . John Wiley and sons, Inc., New York.
7. Goon, A.M., Gupta, M.K. and Dasgupta, B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press
8. Gupta, S.C. and Kapoor, V.K.1997. *Fundamentals of Mathematical Statistic*., Sulthan Chand Publications, New Delhi.
9. Panse, V.G. and Sukhatme, P.V. 1967. *Statistical Methods for Agricultural Workers.* Indian Council of Agricultural Research , New Delhi
10. Rao, G.N. 2007. *Statistics for Agricultural Sciences.* BS publications, Hyderabad.
11. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. 1984. *Sampling Theory of Surveys with Applications*. Iowa State University Press and Indian Soc. of Agric. Stat., New Delhi
12. Learning Statistics: http://freestatistics.altervista.org/en/learning.php.
13. Electronic Statistics : Text Book:

AGRICULTURAL ENGINEERING

1. Engg 1201 Soil and Water and Conservation Engineering (1+1)

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. Engineering measures of soil and water conservation - contouring, contour bund , graded bund and bench terracing Water harvesting and its techniques. Introduction to irrigation – terminologies – irrigation methods – micro irrigation –drip and sprinkler irrigation - fertigation. Introduction to irrigation pumps and their selection.

Practical

Calculation of erosion index and estimation of soil loss, measurement of soil loss, Preparation of contour maps, Estimation of runoff –problems, Water flow measuring devices, Design of contour bunds, graded bunds, Design of bench terracing system, Design of water harvesting ponds , Problems on irrigation efficiencies, Problems on drip and sprinkler irrigation systems, Irrigation pump selection – problems.

Lecture schedule

1. Introduction to Soil and Water Conservation
2. Causes of soil erosion. Definition and agents of soil erosion, water erosion
3. Forms of water erosion
4. Gully classification and control measures.
5. Soil loss estimation by Universal Soil Loss Equation.
6. Soil loss measurement techniques.
7. Principles of erosion control
8. Runoff, types and estimation of runoff
9. Introduction to contouring, strip cropping, contour bund

   Mid Term Examination
10. Introduction to graded bund and bench terracing.
11. Introduction to Water harvesting and ground water recharging
12. Different techniques of water harvesting
13. Introduction to irrigation – terminologies
14. Different methods of irrigation and flow measuring devices
15. Micro irrigation – drip and sprinkler
16. Fertigation- different equipments
17. Introduction to irrigation and drainage pumps -Centrifugal pumps, submersible pumps and axial flow pumps
18. Selection of irrigation pumps - suction head, delivery head, total head and pump efficiencies

Practical schedule

1. Calculation of erosion index and estimation of soil loss by USLE
2. Study of soil loss by multi slot device
3. Preparation of contour maps
4. Estimation of runoff -problems
5. Study of water flow measuring devices
6. Design of contour bunds, graded bunds
7. Design of bench terracing system
8. Study of water harvesting techniques

9. Study of ground water recharge techniques
10. Design of water harvesting ponds
11. Application, conveyance, storage and distribution efficiencies
12. Problems on irrigation efficiencies –
13. Problems on drip irrigation systems
14. Problems on sprinkler irrigation systems
15. Study of fertigation equipments
16. Irrigation pump selection - problems
17. Field visit
18. Practical Examination

Suggested Readings

1. Kumar, S., Kumar, V. and Sahu, R.K.. 2016. *Fundamentals of Agricultural Engineering*, Kalyani Publishers, New Delhi.
2. Mal, B.C. 2014. *Introduction to Soil and Water Conservation Engineering*. Kalyani Publishers.
3. Michael, A.M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House New Delhi
4. Michael, A.M. and Ojha, T.P. 2014. *Principles of Agricultural Engineering* .Vol-II 5th Ed. Jain Brothers Publication, New Delhi.
5. Michael, A.M., Khepar, S.D. and Sondhi, S.K. 2008. *Water Well and Pumps*, 2nd Ed, Tata Mc-Graw Hill.
6. Samra, J.S., Sharda, V.N. and Sikka, A.K. 2002. *Water Harvesting and Recycling: Indian Experiences*. CSWCR&TI, Dehradun, Allied Printers, Dehradun
7. Schwab, G.O., Fangmeier, D.D., Elliot,W,J. and Frevert, R.K. 1993. *Soil and Water Conservation Engineering*. 4th Ed. John Wiley and Sons Inc. New York.
8. Singh, G., Venkataraman, C., Sastry, G. and Joshi, B.P. 1996. *Manual of Soil and Water Conservation Practices*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Suresh, R. 2010. *Principles of Micro-Irrigation Engineering.* Standard Publishers, Distributors, New Delhi.

2. Engg 2102 Farm Machinery and Power (1+1)

Theory

Status of farm power in India - sources of farm power. IC engines - working principles of two stroke and four stroke cycle engines, comparison. Study of different components of IC engines. engine terminology and solved problems, familiarization with different systems of IC engines: Air cleaning, cooling, lubrication, fuel supply systems. Hydraulic control and power transmission system of Tractor: clutch, gear box, differential and final drive. Tractor types, cost analysis of tractor power and attached implements. Familiarization with primary and secondary tillage implements, implements for hill agriculture, implements of intercultural operations. Familiarization with sowing and planting equipments, calibration of a seed dirll and solved examples. Familiarization with Plant protection equipments. Familiarization with harvesting and threshing equipments.

Practical

Study of different components of I.C. engine. Study of air cleaning and fuel supply system of tractor engine. Study of cooling system and lubrication system of tractor engine. Familiarization with clutch, transmission gear box, differential and final drive of a tractor. Familiarization with hydraulic control system of tractor. Learning of tractor driving. Familiarization with operation of power tiller-Implements for hill agriculture, Familiarization with different types of primary tillage implements: mould plough, disc plough, subsoiler, and chisel plough. Familiarization with different types of secondary tillage implements harrows, cultivators and rotavators. Familiarization with seed-cum-

fertilizer drills their seed metering mechanism and calibration. Planters and transplanter, Familiarization with plant protection equipments- different types of sprayers and dusters Familiarization with different inter-cultivation equipment. Familiarization with harvesting and threshing machinery.

Lecture schedule

1. Status of farm power in India and Kerala- sources of farm power – merits and demerits of different forms of power. Farm mechanization-scope of farm mechanization-present status of mechanization-limiting factors and suggestions of farm mechanization.
2. Principle of working of internal combustion engines- four stroke cycle engine-two stroke cycle engine.
3. Terminology connected with engine power-swept volume-compression ratio-indicated horse power-brake horse power-problems.
4. Fuel system, lubrication system and cooling systems of IC engines
5. Farm tractor-classification-tractor components-selection of tractor
6. Power transmission system of a tractor-clutch, gear box, differential and final drive.
7. Hydraulic system of tractor-basic components and types of hydraulic system, implement control and hitching of implements- trailed, semi-mounted and mounted.
8. Estimating the cost of tractor power-problems and tractor selection.
9. Power tiller-components of power tiller-power transmission in power tiller.

   Mid Term Examination
10. Tillage-objectives of tillage-classification and types of tillage. Ploughing of land-furrow, furrow slice, furrow wall, crown. Back furrow. Dead furrow, methods of ploughing, gathering and casting.
11. Types of plough-indigenous plough. Mould board plough- types of share, types of mould board, plough accessories - vertical suction, horizontal suction and throat clearance
12. Disc plough-advantage and disadvantages-types of disc plough-standard and vertical disc plough-disc angle-tilt angle.
13. Adjustments and repairs of ploughs-chisel plough-subsoiler-rotary plough.
14. Harrows-Disc harrow- types, components and other harrows. Cultivator, Puddler, bund former, ridger and other intercultural implements.
15. Seed drill and seed cum fertilizer drill-seed metering mechanism-components and types. Calibration of seed drill. Planter functions-seed metering devices in a planter.
16. Plant protection equipment-sprayers-types and classification, components of power sprayer, care and maintenance of power sprayers. Duster-types of duster.
17. Harvesting equipments- mowers and reapers. Vertical conveyor reaper – types. Principles of threshing.
18. Threshers – types of threshers. Introduction to working of Combine harvesters, types of combines.

Practical schedule

1. Study of tools and equipments in a farm machinery workshop
2. Study of different components of an IC engine
3. Study of four stroke cycle engine
4. Study of two stroke cycle engine
5. Study of different components of power tiller
6. Study of operation and maintenance of power tiller
7. Field operation with power tiller
8. Study of different components of tractor
9. Study of operation and maintenance of tractor
10. Study of Mould Board plough and its adjustments
11. Study of disc plough and its adjustments
12. Study of cultivators and its adjustment and Study of Harrows

13. Study of paddy transplanter
14. Study of seed drill and its calibration
15. Study of planters and different metering mechanisms
16. Study of sprayers and dusters and its calibration
17. Study of Harvester, Mower, and threshers
18. Practical Examination

Suggested Readings

1. Kumar,S., Kumar, V. and Sahu, R.K. 2016. *Fundamentals of Agricultural Engineering.* Kalyani Publishers, New Delhi.
2. Ojha, T.P. and Michael, A.M. *Principles of Agricultural Engineering*, Vol.I. Jain Brothers, New Delhi.

3. Engg 3103 Protected Cultivation and Secondary Agriculture (1+1)

Theory

Green house technology- Introduction, types of Green Houses; Plant response to Green house 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 green houses; Passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis.Cleaning and grading - methods and equipments; cleaners and separators, colour sorter, Drying - principles, classification- conduction, convection and radiation driers, moisture contents, theory of grain drying; Drying- Constant and falling rate of drying, efficiency of drying; Types of dryers- mechanical dryers - working principles; Material handling equipment; conveyer and elevators, working and selection; Effect of temperature, Relative humidity and gas composition on storage, Storage structures - traditional modified and controlled atmosphere structures ; Food quality measurements- destructive and non destructive methods- principles.; HACCP, GAP, GMP, and quality standards.

Practical

Different types of green houses. Calculation of air exchange rate, Design and estimation of green house, Irrigation equipments in green houses, growing media used in raising of greenhouse crops and their preparation .Determination of moisture content by different methods , cleaners, graders, and driers- components and efficiencies. Storage structures.

Lecture schedule

1. Green house technology: introduction, concept & principles- Types of Green Houses; classification of green houses –
2. Naturally and artificially ventilated green houses.
3. Plant response to green house environment, Temperature, relative humidity, light and carbon dioxide control.
4. Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes.
5. Irrigation systems in green house and its applications
6. Green house equipment, materials of construction for traditional and low cost green houses.
7. Passive solar green house, green house drying.
8. Cleaning and grading, methods of grading, equipment for grading
9. Different cleaners and separators- length separator, cyclone separator.

Mid Term Examination

10. Specific gravity separator, colour sorter, separators based on surface texture.

11. Drying, principles, classification- conduction, convection and radiation driers, moisture contents, theory of grain drying.
12. Drying- Constant and falling rate of drying, deep bed and shallow bed drying - efficiency of drying.
13. Types of dryers- mechanical dryers, cross flow, concurrent flow, …….flow , batch, continuous, mixing and non mixing dryers- working principles.
14. Material handling equipment; conveyer and elevators, their principle, working and selection
15. Effect of temperature, Relative humidity and gas composition, traditional storages, Modified and Controlled atmosphere storage structures.
16. Food quality, measurements- destructive and non destructive methods- principles.
17. HACCP, GAP
18. GMP, and quality standards

Practical schedule

1. Study of different types of green houses based on shape, construction and cladding materials.
2. Calculation of air exchange rate
3. Design of green house
4. Estimation of cost of green houses
5. Study of Irrigation equipments in green houses
6. Study of various growing media used in raising of greenhouse crops and their preparation and pasteurization/ sterilization.
7. Visit to commercial green houses.
8. Determination of moisture content by moisture meter
9. Determination of Moisture content of various grains by oven drying/infrared moisture methods
10. Study of cleaners their components.
11. Study of graders their components.
12. Study of dryers their components.
13. Study of storage structures
14. Drying rate and drying efficiency calculations
15. Study of other PHT equipments
16. Visit to cold storage structure
17. Visit to grain processing centre
18. Practical Examination.

Suggested Readings

1. Kumar, S., Kumar, V. and Sahu, R.K. 2016. *Fundamentals of Agricultural Engineering*. Kalyani Publishers, New Delhi.
2. Manohar, K.R. and Thinathane, I.C. 2007. *Greenhouse technology and management*. B.S.Publications, Hyderabad.
3. Nelson, P.V. 2011. *Greenhouse operation and maintenance*. Prentice Hal.
4. Pandey. 2006. *Principles of Agricultural Processing* . Kalyani Publishers, New Delhi.
5. Prasad and Kumar. 2012. *Greenhouse management for horticulture crops*. Agrobios (India), Jodhpur
6. *The Food Safety and Standards Act along with Rules & Regulations.* Commercial Law Publishers (India) Pvt. Ltd.

4. Engg 3204 Renewable Energy and Green Technology (1+1)

Theory

Classification of energy sources, contribution of these sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application, Familiarization with types of biogas plants and gasifiers, biogas, bio-alcohol, bio-diesel and bio-oil production and their utilization as bio-energy 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

Energy input in agricultural production - biogas plant – different types, design of biogas plant. Biomass gasifier, Study of production process of bio diesel, study of production process of bio fuel, study of briquetting, solar water heating, solar cookers, solar pumping, solar dryers, Design of solar driers, solar photovoltaic cell characteristics, study of types of wind mills.

Lecture schedule

1. Sources of energy - Classification, renewable and non renewable energy.
2. Properties of different types of renewable energy sources
3. Energy from bio-mass – types. Biogas production and utilization.
4. Types and construction of biogas plants.
5. Agricultural wastes, principles of combustion, pyrolysis and gasification of biomass
6. Types of gasifiers, producer gas and its utilization.
7. Briquettes, types of Briquetting, uses of briquettes, shredders.
8. Solar energy – solar collectors - flat plate and focussing plate collectors
9. Solar air heaters, solar space heating and cooling

Mid Term Examination

10. Solar energy applications/solar energy gadgets, solar cookers, solar water heating systems
11. Solar grain dryers, solar refrigeration system, solar ponds
12. Solar photovoltaic systems, solar lantern, solar street lights, solar fencing
13. Solar pumping systems
14. Wind energy, types of wind mills
15. Construction details and application of wind mills
16. Liquid bio fuels -Bio diesel and ethanol from agricultural produce

17-18. Production of bio diesel

Practical schedule

1. Estimation of energy input in agricultural production
2. Study of biogas plant – fixed dome type
3. Study of biogas plant – floating dome type
4. Design of biogas plant
5. Study of a biomass gasifier
6. Study of production process of bio diesel
7. Study of production process of bio fuel
8. Study of briquetting
9. Study of solar water heating system
10. Study of solar cookers
11. Visit to solar energy plants

12. Study of solar pumping system
13. Study of solar dryers
14. Solar drying experiment
15. Design of solar driers
16. Study of solar photovoltaic cell characteristics
17. Visit to a wind farm
18. Practical Examination

Suggested Readings

1. Kumar, S., Kumar, V. and Sahu, R.K. 2016. *Fundamentals of Agricultural Engineering.* Kalyani Publishers, New Delhi.
2. Mathur, A.N. and Rathore, N.S. 1992. *Biogas production, management and utilization*. Himanshu Publication. Delhi.
3. Ojha, T.P. and A.M.Michael. Principles of Agricultural Engineering, Vol.I. Jain Brothers New Delhi.
4. Rai, G.D. 2013. *Non-Conventional Energy Sources*, Khanna Publishers, Delhi.
5. Rathore N. S., Kurchania, A. K., Panwar, N. L. 2007. *Renewable Energy, Theory and Practice*, Himanshu Publications.
6. 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
7. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable *Energy Resources: Basic Principles and Applications*. Narosa Pub. House. Delhi.

AGRICULTURAL ECONOMICS

1. Econ 1201 Fundamentals of Agricultural Economics (2+0)

Theory

Economics: Meaning, scope and subject matter, definitionsapproaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. *Demand:* meaning, law of demand, demand schedule and demand curve, determinants, Elasticity of demand: concept degrees of elasticity and measurement of price elasticity, income elasticity and cross elasticity. Utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Production: process, creation of utility, factors of production, input output relationship. *Cost:* Cost concepts- fixed cost, variable cost Supply: Stock v/s supply, law of supply, 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; 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. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation. 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, VAT. *Economic systems:* Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies. Welfare Economics – meaning and definition.

Lecture schedule

1- 2	*Economics:* Meaning, scope and subject matter, definitions approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium.
3	Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior.
4	Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development
5 -6	Basic concepts: Goods and services, desire, want, demand, utility – forms , cost and price, wealth, capital, income and welfare
7-9	*Demand:* meaning, law of demand, demand schedule and demand curve, determinants, Elasticity of demand: concept degrees of elasticity and measurement of price elasticity, income elasticity and cross elasticity
10-11	Utility- cardinal, ordinal ; theories- law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve First internal exam
12	Concept of consumer surplus –diagrammatic representation- applications and uses
13-14	Production: process, creation of utility, factors of production, input output relationship.
15-16	*Cost:* Cost concepts, Fixed and variable costs. Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply.
17-18	Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition

Mid Term Examination

19-20 Distribution - factor market - meaning – theories, Marginal productivity, Demand –Supply theory.

21-22 Ricardian theory and modern theory of rent - and pricing of factors of production. Concepts of rent, wage, interest and profit.
Second internal exam

23-24 *National income:* Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement.

25-27 Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation.

28-30 Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure.

31 *Tax:* meaning, direct and indirect taxes, agricultural taxation, VAT.

32-34 *Economic systems:* Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies.

35-36 Welfare Economics – concept- definition –importance- Pareto optimality

Suggested Readings:

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. Kenneth, E.B.1941. *Economic Analysis*. Harper and Row, New York.
5. Reddy,S., Raghuram,P., Neelakantan,T.V. and Bhavani D. I. 2004. *Agricultural Economics*. Oxford and IBH Publishers, New Delhi.

2. Econ 2102 Agricultural Finance and Co-Operation (1+1)

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. Seminar on selected topics.

Lecture schedule

1	Agricultural Finance – Introduction-Scope and Definition
2	Agricultural Credit-meaning-definition-need
3	Classification of Agricultural Credit – source-period-security-liquidity-purpose
4	Credit Analysis – 3 R's – 5 C's – 7 P's – Repayment Plans – Diminishing and Even repayment plan
5-6	History of Agricultural Financing in India – Taccavi loans – Co-operative Credit Act – RBI Act – Social Control –Nationalization –Formation of RRBs.
7	Sources of Agricultural credit – non institutional sources-money lenders-indigenous bankers-merits and demerits
8-9	Institutional sources-Commercial Banks-Lead Bank Scheme-Service Area Approach-RBI-Stipulation in Agricultural lending, Micro Finance, KCC, Small Banks
	Mid Term Examination
10	Regional Rural Banks-Genesis-structure-functions
11	NABARD-Establishment-Role and Functions
12	RBI and Agricultural Credit – A brief exposition to Asian Development Bank-World Bank-IMF-DICGC.
13	Crop Insurance Schemes in India, Micro Finance, KCC, Small Banks- Recent developments in agricultural credit.
14	Co-operation-Definition-Principles of Co-operation-
15-18	Co-operative credit structure-short, medium and long term-PACS, PSS, DCCB, SCB, PCARDB, SCARDB

Practical schedule

1.	Documentation of Basic Statistics on Agricultural Finance
2-4	Procedure for getting farm loans from various institutions-Cooperation-Commercial Banks-RRBs
4-6	Estimation of credit needs – Farm level survey
7.	Scale of Finance-for various crops in different districts-comparison with cost of cultivation-credit needs
8.	Unit Cost-Understanding NABARD schemes.
9.	Preparation and Analysis of loan proposals-3 Rs of Credit
10-12	Projects- Techno economic feasibility Preparation of Project report
13.	Preparation of repayment Plans
14.	Preparation/analysis of Balance Sheet & Income statement
15-16	Visit to PACs/DCB/SCB/CB/RRBs
17	Overview of agricultural credit system in India/Kerala (analysis based on secondary data)
18	Practical Examination

Suggested Readings

1. Lins, D.A. and Penson, J.B. 1980. *AgrculturalFinanace:an introduction to Micro & Macro Concepts.* Prentice-Hallnc Publishers, New Jersy
2. Mohanan, N. 1981. *Development Finance for Small Farmeres*. Rainbow Publishers, Coimbatore
3. Nakkiran, S. 1980. *Agricultural Finance and Rural Banking in India: an Evaluation*. Rainbow Publishers, Coimbatore
4. Paramjith, I.and Ravi, V.G. 1980. *Agricultural Finance by Commercial Banks*. Ashish Publishing Home, New Delhi

5. Reddy, S. and Ram, P.R.2005. *Agricultural Finance and Management*.Oxford and IBH Publishers, New Delhi.
6. Reddy, S., Raghuram, P., Neelakantan,T.V and Bhavani, D.I. 2004. *Agricultural Economics*. Oxford and IBH Publishers, New Delhi.
7. Tomar, J.S. 1978. *Farm Credit &Finance*.Verma Brothers, Delhi

Websites

SCB: http://www.keralacobank.com

RBI: https://www.rbi.org.in

NABARD: https://www.nabard.org

World Bank: http://www.worldbank.org

ADB: http://www.adb.org

RRB: http://www.keralagbank.com

Lead Bank: http://www.canarabank.com

SLBC: http://www.slbckerala.com

3. Econ 3103 Farm Management, Production and Resource Economics (2+1)

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, Types and systems of farming and characteristics, factors 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 labor 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, valuation of farm assets-depreciation- 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 enterprises. Concept of risk and uncertainty in agricultural 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 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.

Lecture schedule

1-2	Farm management - Meaning – Concept-Definitions of Farm Management – Scope of Farm Management – Relationship with other sciences.
3	Production Economics – Definitions – Nature – Scope and subject matter of Production Ecnomics – Objectives of Production Economics.
4-5	Basic terms and concepts of Production Economics and Farm management Meaning and definition of farms, its types and characteristics, factors determining types and size of farms.
5	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.
6-7	Factor – product relationship – Laws of Returns – increasing, constant and decreasing returns-Law of Diminishing returns – Total product-Average product-marginal product-Elasticity of Production –Product curves-Three stages of production function – Limitations -Returns to scale-Types
8-9	Meaning and concept of cost, types of costs and their interrelationship, ABC cost importance of cost in managing farm business and estimation of gross farm income, net farm income, family labor income and farm business income.
10-11	Cost Function- Types of costs-cost curves- stages of cost function-Relationship between cost curves and product curves- cost of cultivation-cost of production-Profit maximization and loss minimization
12-13	Factor – Factor relationship – Isoquants and their characteristics – MRTS – Types of factor substitution- Iso –cost lines – Characteristics.
14-15	Principle of Resource substitution Methods of Determining Least-cost combination of resources – Expansion path – Isoclines – Ridge lines.
16-17	Product – product relationship – product possibility curves – Marginal rate of product substitution – Types of enterprise relationships – Joint products -Complementary - Supplementary – Competitive and Antagonistic products
18	Iso – revenue line and characteristics – principle of product substitution-Methods of determining optimum combination of products – Expansion path – Ridge lines
	Mid Term Examination
19	Law of Equi-marginal returns – Meaning-importance-Illustration- law of equi-marginal/or principles of opportunity cost and law of comparative advantage
20-21	Time comparison principle, Importance- Compounding and discounting method- Capital productivity analysis- Pay back period-Net Present Worth-Benefit - Cost ratio- Internal rate of Return
22	Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Tools of farm management analysis.
23-24	Farm records-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
25	Farm planning – Meaning – Need for farm planning – Types of Farm plans – simple farm plan and whole farm plan – characteristics of a good farm plan
26-27	Farm budgeting – meaning – types of farm budgets – Enterprise budgeting – Partial budgeting and whole farm budgeting. – basic steps in farm planning and budgeting
28	Linear programming, appraisal of farm resources, selection of crops and livestock's enterprises

29-30 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.

31 Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources - Positive and negative externalities in agriculture.

32 Inefficiency and welfare loss, solutions-Important issues in economics and management of common property resources of land, water, pasture and forest resources

33-34 Farm inventory- Methods of valuation of farm assets-Depreciation- Meaning-Methods of computation of depreciation

35-36 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

Practical schedule

1 Exercise on problems related to farm management principles- Determination of most profitable level of inputs use in a farm production process.

2 Determination of least cost combination of inputs. Selection of most profitable enterprise combination.

3 Application of equi-marginal returns/opportunity cost principle in allocation of farm resources

4-5 Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises

6-9 Preparation of interview schedule -Estimation of cost of crop and livestock enterprices

10-12 Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets.

13-14 Preparation of farm plan and budget

15 Analysis of farm records and accounts farm inventory, balance sheet, profit and loss accounts.

16 Computation of depreciation using different methods

17 Visit to college farm and cost and return analysis

18 Practical Examination

Suggested Readings

1. Dhondyal, S.P.1987. *Farm management: An Economic Analysis* .Friends Publications, Meerut.
2. Gittinger, J.P.1973. *Economic Analysis of Agricultural Projects* . The Johns Hopkins University Press, Baltimore.
3. Johl, S.S. and Kapur, T.R. 2000. *Fundamentals of Farm Business Management.* Kalyani Publishers, New Delhi
4. Kahlon, A.S. and Singh.K.. 1992. *Economics of Farm Management in India*. *Theory and Practice*, Allied Publishers.
5. Reddy, S. S., Ram, P.R ., T.V.N. and Dev, J.B. 2004. *Agricultural Economics*.Oxford& IBH Publishing Co. Private Limited, New Delhi.

4. Econ 3204 Agricultural Marketing, Trade & Prices (2+1)

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

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.

Lecture schedule

1	Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing.
2-3	Market structure, market conduct and performance-marketing mix- Marketing mix- 5 Ps of Marketing- Product- Place-Product life cycles, Price- Promotion- People/Perception and market segmentation- Market segmentation- Meaning and need- basis of segmentation
4-5	Classification of market-based on commodity, location, volume of business, time, Competition, classification and characteristics of agricultural markets
5	Producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities;
6-7	Market demand supply nature and determinants of demand and supply of farm products, Price determination
8-10	Marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions
11-12	Storage, transport and processing; facilitating functions – packaging, branding,
13	Grading and Standardisation, types of grading, quality control and labelling (Agmark); international quality standards
14-15	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;

16-17 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;

18-19 Integration, efficiency- Meaning, definition and types of market integration; marketing efficiency; Types, factors affecting efficiency, methods of evaluating efficiency

Mid Term Examination

20-21 Marketing costs, margins and price spread and other cocepts; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs;

22-23 Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India;

24-25 Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading;

26-27 Marketing Management- Product life cycle (PLC) and competitive strategies: Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC;

28-29 Pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion

30-31 Advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits;

32 Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; price stabilisation

33-34 Trade: Concept of International Trade and its need,Globalisation and liberalization theories of absolute and comparative advantage. Leonteif's paradox-Present status and prospects of international trade in agri-commodities

35 GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture

36 IPR concepts and meaning, importance and applications.

Practical schedule

1 Study of price behaviour over time for some selected commodities, based on secondary data

2 Plotting market demand and supply curves

3 Analysis of the problems on elasticities

4-5 Visit to a local market to study various marketing functions performed by different agencies and study of relationship between market arrivals and prices of some selected commodities

6-8 Conduct study on iidentification of marketing channels and computation of marketable and marketed surplus of important commodities

9 Construction of index numbers- simple and weighted using different methods

10 Visit to co-operative marketing institutions and evaluation of the functioning

11 Visit to CWC/SWC and evaluation of the functioning

12 Visit to Central/State Agmark Laboratory and evaluation of the functioning

13-16 Collection of data regarding marketing costs, margins and price spread and presentation of report in the class

17 Application of principles of comparative advantage of international trade.

18 Practical Examination

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L.1994. *Agricultural Prices and Policy*. Oxford and IBH, New Delhi.

2. Acharya, S.S. and Agarwal, N.L.1987. *Agricultural Marketing in India*. Oxford and IBH, New Delhi.

3. Alagumani ,T., Chinnaiyan, P. and Elangovan, S.1998. *Agricultural Management* . Publishers K9 International, Madurai.

4. Downey,W.D. and Troche, J. K.1981. *Agribusiness Management*. McGraw Hill Inc.,New Delhi

5. Gittinger, J.P.1982. *Economic Analysis of Agricultural Projects*. The Johns HopkinsUniversity Press, Baltimore

6. Philip, K. 2004. *Marketing Management*. Prentice Hall, New Delhi.

7. Philip, K. 2004. *Principles of Marketing*. Prentice Hall, New Delhi.

ANIMAL HUSBANDRY

1. Anhs 1201 Livestock and Poultry Management (1+1)

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 goat. 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 Classification of feedstuffs. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. 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, and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

Theory schedule

1. Introduction Role of Livestock in Indian Agriculture Livestock census
2. Livestock development agencies and Programmes in Kerala
3. Definition of Breed – Classification of indigenous and exotic cattle Breed characteristics of Sindhi, Kangayam, Kankrej, Jersey, Holstein Friesian, Brown Swiss, Murrah and Surti.
4. Systems of mating – importance of cross breeding. Female reproductive system
5. Oestrous cycle signs of heat, Time of A.I. Artificial insemination merits and demerits –
6. Care &management of pregnant cow Gestation period in different species
7. Care and management of new born calf, Milk definition, Composition of milk
8. Factors affecting milk yield and composition, Clean milk production
9. Preservation of milk – Pasteurization and other methods.

   Mid Term Examination
10. Nutrition–definition, Ration Balanced ration Requirement and importance of green fodder
11. Importance of health care & signs of health in cattle

12-14 Common. Diseases of cattle and poultry, Basic principles in controlling infectious and contagious diseases and control.

15. Goat farming, breeds indigenous and exotic, Goats Housing and feeding
16. Swine husbandry – common breeds
17. Poultry Definition, Introduction of systems of poultry rearing, Brooding and rearing of chicks
18. Rearing of growers and layers, Broiler rearing, Common diseases symptoms and Vaccination schedule for poultry.

Practical schedule

1. Body parts of cow
2. Identification of animals
3. Instruments used in Animal Husbandry practices

4. Ageing of cattle
5. Housing of Cattle
6. Milking of animals
7. Physical examination of milk and Determination of Specific gravity
8. Determination of Fat percentage, Total solids, Solid Not Fat
9. Legal standards of milk, Determination of adulterants in milk
10. Common cattle feeds and their classification
11. Measuring usefulness of feed
12. Feeding and calculation of feed for Dairy cattle
13. Body parts and Handling of birds
14. Classification of Poultry
15. Housing and management of poultry, visit to poultry farm, culling of unproductive birds Demonstration of vaccination and deworming
16. Broiler, poultry farming
17. Cost benefit analysis
18. Practical Examination

Suggested Readings

1. Banerjee, G.C. 1998. *The Text Book of Animal Husbandry*. Oxford and IBH Publishing, Calcutta
2. Gopalakrishnan, C.A. and Lal, D.M.M., 1992. *Livestock and Poultry Enterprises for Rural Development*. Vikas Publishing House Private Limited,Ghaziabad, U.P.,
3. ICAR. 2001. *A Hand Book of Animal Husbandry*. Indian Poultry Industry Year Book 1998. A25 Priyadarshini Vihar, DELHI.
4. Kadirvel, R. and Balakrishnan, V. 1998. *Hand Book of Poultry Nutrition*. Madras Veterinary College, TANUVAS, Chennai 7.
5. Maynard, C. and Loosli, S. 1989. *Animal Nutrition*. Tata Mc Graw Hill Publishing Company Limited, New delhi.
6. Prabakaran, R. 1998. *Commercial Chicken Production*. Publisher P.Saranya, 5/2, Ramalingam Street, Seven Wells, Chennai1.
7. Sastry, N.S.R., Thomas, C.K. and Singh, R.A. 1982. *Farm Animal Management and Poultry Production*. Vikas Publishing House Private Limited, Ghaziabad, Uttar Pradesh.
8. Sukumar De. 1980. *Outlines of Dairy Technology*. Oxford University Press, Delhi.
9. Sharma. R.P., Chatterjee, R.N., Rama Rao, S.V. and Sharma. S.R, 2008. *Poultry production in India.* Directorate of Information and Publication of Agriculture, Indian Council of Agriculture Research,New Delhi.
10. Watter, H.P. and Robert, H.G. 2001. *Livestock Production*. Green World Publications, Indira Nagar, Lucknow

AGRICULTURAL EXTENSION

1. Extn 1101 Rural Sociology & Educational Psychology (2+0)

Theory

Sociology and Rural sociology: Definition and scope, its significance in agricultural extension, Social ecology, Rural society, Social groups, Social stratification, culture concept, Social institution, Social change & development. Educational psychology: meaning & its importance in agricultural extension. Behaviour: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

Lecture schedule

1. Sociology- Concept, meaning and scope-classification
2. Rural sociology - concept and meaning- characteristics of a rural society.
3. Society - rural/urban difference: comparison
4. Social institutions – definition, and characteristics
5. Functions of social institutions – physical and symbolic trails of social institution
6. Family as a social institution – meaning, concept and functions
7. Ecological entities – society, community and neighborhood
8. Social organizations – definition, meaning and functions
9. Social groups – types, characteristics and importance
10. Social process - meaning, definition and types
11. Stratification – meaning, definition and types
12,13 Culture – meaning and definition, cultural concepts – traits, complexes and patterns, characteristics of culture
14,15. Social change – definition, factors affecting social change
16.17 Theories of social change – linear theory, cyclic theory and deterministic theory
18. Sociological concepts – norms, folkways, mores, customs and taboos, social problems.

Mid Term Examination

19. Psychology – concept, meaning scope and limitations.
20. Branches of psychology and its application
21. Educational psychology – definition, concept, principles and scope
22. Human behaviour- stimulus response mechanism
23. Cognitive, affective and psychomotor domain.
24. Behavioural mechanism – classical Vs operant conditioning
25 Personality- definitions & importance - types of personality, factors affecting personality
26, 27 Learning – definitions and concepts – elements of learning and types of learning – teaching - Adult education.
28. Motivation – definition, concept and meaning and factors affecting motivation.
29. Motives – types
30. Theories of motivation
31, 32 Attitudes and values – types, techniques and importance
33,34 Intelligence – definition and types , measurement
35,36 Factors affecting intelligence - Theories of intelligence

Suggested Readings

1. Bhatia, H.R. 1968. *General Psychology*. Oxford and IBH Publishing Company, New Delhi.
2. Chitambar, J.B. 1977. *Introductory rural sociology* .Wiley Eastern Ltd, New Delhi
3. Desai, A.R. 2003. *Rural sociology in India.* Popular Prakasan, *Bo*mbay.
4 Partha Sarathi De., 2012. *Rural Sociology*. Pearson Education, New Delhi

5 Plotnik, R. and Mollenauer, S. 1986. *Introduction to Psychology*. Random House, New York.
6 Reddy, A.A . 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.
7 Sachdeva, D.R. and Bhushan,V. 1974. *An introduction to Sociology*, Kitab Mahal.S.D., Pvt.Ltd, Allahabad
8 Samanta, R.K. and Arora,S.K. (Eds) . 1997. *An introduction to Sociology*. Kitab Mahal.S.D., Pvt.Ltd. Allahabad
9 Samanta, R.K. and Arora, S.K. (Eds) 1997. *Management of Agricultural Extension in global Perspectives.* B.R.Publishing Corporation, New Delhi.
10 Sharma, R.N.1975. *Introductory Sociology*. Rajhans Prakashan mandir, Meerut.
11 Skinner Charles, E. 1990. *Educational Psychology*. Prentice Hall of India Pvt. Ltd., New Delhi
12 Woliman, B.B. 1973. *Hand Book of General Psychology*. Prentice Hall, Englewood, New Jersey.

2. Extn 1203 Fundamentals of Extension Education and Rural Development (2+1)

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

Practical

To get acquainted with university extension system. Preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; 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.

Lecture schedule

1 Education - meaning, definition & types, history of xtension - Morril and Smith Lever Act; 4 H Clubs – structure and function
2 Extension education and agricultural extension : meaning, definition, scope and process; objectives and principles of extension education
3 Rural development: concept, meaning, definition, Community Development - meaning,

	definition, concept & principles, philosophy of C.D. rural leadership: concept and definition, types of leaders in rural context
4	Development approaches in extension, annual plans and five year plans.
5,6	Extension systems in India: extension efforts in pre-independence era (Economic conference of Mysore, Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, Gandhian constructive Programme)
7, 8	Developmental pogrammes of post-independence era (Firka Development , Etawah Pilot Project, Nilokheri Experiment, and various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP,IRDP, HYVP, KVK, IVLP, ORP, ND,NATP, NAIP, NAEP,IVLP, ARYA, Student Ready of ICAR.
9, 10	Communicty Development programme – meaning, definitions, concepts, philosophy, principles, objectives , difference between community development and extension education. National extension service – features, difference between community development and national extension service
11, 12	Panchayath Raj system – meaning and democratic decentralization and Panchayath Raj three tires of Panchayath Raj system – power, function and organizational setup.
13	Reorganized extension system (T&V System) salient features, fortnightly meetings, monthly workshops, linkages, merits and demerits.
14, 15	Various rural development programmes launched by Govt. of India SwarnaJayanthi Grama Swaraj Yojana (SGSY), Prime Ministers Employment Yojana (PMEY) MGNREGS, Crop Insurance Programmes - ABARD,ATIC, ATMA, ATMA Plus and LEADS
16, 17	Extension programme planning - meaning, process, principles and steps in programme development - PRA concept – New schemes and programme in rural development.
18	Participatory Technology Development - meaning, process, principles and steps in PTD
	Mid Term Examination
19	Gender - meaning and concept, gender main streaming – gender planning and women developing programmes
20	New trends in agricultural extension : privatization extension, market-led extension, farmer-led extension
21	Extension administration: meaning and concept, principles and functions, concepts of extension Management.
22,23	Extension leadership – types, theories and applications, importance of leadership in agricultural extension.
24,25	Monitoring and evaluation - concept and definition, types and methods, degrees of evaluation, types of evaluation. Advantages of monitoring and evaluation of extension programmes
26,27	Transfer of technology: concept and models. Technology Assessment and Refinement (TAR) frontline demonstration(FLD) and on farm testing (OFT)
28-29	Extension teaching methods - meaning, classification - individual, group and mass contact methods. Principles of teaching and learning, Steps in teaching, elements of learning. Factors facilitating teaching-learning process.
30-31	Training, meaning, definition and importance; difference between training and education, types of training. Techniques of training – Training need assessment.
32-33	Cyber extension/ e-extension - meaning and concept, principles and functions. Evolution of e-Extension technologies.
34-35	ICT applications in TOT- MIS, DSS, expert systems in Agriculture , online and offline agricultural e-Extension systems
36	Different new and social media, media mix strategies for agricultural extension.

Practical schedule

1,2	PRA tools and techniques
3,4	Basic data generation from nearby village selected for PRA
5	Conduct of PRA
6	Review of PRA with presentations and consolidation of report

7,8,9 Visit to rural development organisations.
10,11 Visit to progressive farms.
12,13 Practicals on techniques of monitoring and evaluation.
14,15 Practicals on extension teaching methods.
16,17 Practicals on programme planning with special thrust to preparation of calendar of operation
18 Practical Examination

Suggested Readings

1. Adhikary, M.M., Sarkar, A., Acharia,S.K. and Basu, D. 2006. *Participatory Planning and Project Management in Extension Sciences.* Agrotech Publishing Company, Udhaipur.
2. De, Dipak. 2011. *A handbook of Extension education*. JV Publishing House, Jodhpur
3. Dharma, O.P. and Bhatnagar, O.P. 2003. Education and communication for *Development*. Oxford, IBH, New Delhi.
4. Govind, S. and Tamil Selvi.G. 2011. *Extension Education and Rural Development* . JV publishing House, Jodhpur
5. Gupta, D.D. 2011. *Extension Education-Core contents and Emerging areas.* JV Publishing House, Jodhpur
6. Ray, G.L. 2006. *Extension communication and Managemen.* New Delhi, Kalyani Publishers
7. Samanta, R.K and Chandra Gowda . 2002. *KVK- The Capacity Builder of Farmers*. New Delhi, B.R. Publishing Corporation
8. Samanta, R.K. 1991. *Agricultural Extension in Changing World Perspective*. New Delhi, Uppal Publishing House.
9. Van Den Ban, A.W. and Hawkins, H.S. 1998. *Agricultural Extension* (2nd Ed). New Delhi, CBS Publishers and Distributors.
10. Vasanth Kumar, J. 2007. *New Dimensions and approaches in Extension Pluralism for Rural Development.* J.V. Publishing House, Jodhpur.

Websites
1. www.planning commission.nic.in
2. www.agricoop.nic.in
3. www.rural.nic.in

3. Extn 2204 Communication Skills and Personality Development (1+1)

Theory

Communication skills: structural and functional grammar; meaning and process of communication, verbal and nonverbal 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 and abstracting; individual and group presentations, impromptu presentation and public speaking. Group discussion. Organizing seminars and conferences. 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. Agricultural journalism. Diffusion and adoption of innovation - concept and meaning, process and stages of adoption. Adopter categories.

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 and abstracting. Individual and group presentations.

Lecture schedule

1. Communication – meaning, definition, concept, importance and special features of agricultural communication
2. Communication skills – concept, meaning and types of communication skills.
3. Writing skills - structural and functional grammar
4. Field diary and lab record; indexing, foot note and bibliographic procedure. Reading and comprehension of general and technical articles – tips. Summarizing and abstracting. Précis writing
5. Levels of communication – interpersonal, intrapersonal, group, public and mass communication. Organizational communication - meaning and types. Elements of communication – source, message, channel receiver and feedback.
6. Communication models – an analysis of models of Berlo, Leagans, Shannon and Weaver, Schramm and communication flow model.
7. Barriers in communication and overcoming barriers. Defensiveness in communication. Communication skills - verbal and non verbal.
8. Agricultural journalism – definition, importance and types. Journalism through distance education mode. Writing for farm families.
9. Public speaking - types, purpose and methods of presentation. Micro teaching

Mid Term Examination

10. Reading, listening, comprehension and oral presentation skills.
11. Audio Visual aids (AV aids) - meaning, importance and classification. Cone of experience. IT/ICT applications in agriculture.
12. Innovative information sources – internet, cyber-café, video conference, teleconference, KISSAN call centers, consultancy clinics, expert systems, information KIOSKs, voice & text messages. Media mix – meaning and techniques.
13. Communication in social system- diffusion and adoption – key communicators and their role in communication.
14. Adopter categories, characteristics of adopter categories and rate of adoption. Models of adoption process and factors influencing adoption.
15. Personality development – meaning and importance. Types of personality. Interpersonal relationships.
16. Time management - meaning and importance. Time logs. Symptoms of bad time management and time management strategies.
17. Stress management - meaning definition and importance. Levels and stages of stress. Stress management stratagies.
18. Crisis management- concept, meaning and strategies for crisis management.

Practical schedule

1. Reading and comprehension of general and technical articles.
2. Practice session on précis writing.
3. Practical exercises on summarizing and abstracting.

4,5,6 Oral Communication –presentation by students – power point presentations – micro teaching.

7,8 Practice sessions on group discussions and method demonstrations

9,10 Practice sessions on listening skill, indexing and bibliographic procedures.

11,12 Preparation of field diary and lab records.

13.14 Preparation of AV aids - posters, cartoon, grid drawing, pattern drawing, collage, strip-tease chart and pull chart

15,16 Practical training on handling projected visual aids.

17 Practical exercise on non verbal communication skills.

18 Practical Examination

Suggested Readings

1. Applebaum, R.L., Anaatol, K.W.E., Hays, E.R., Jensan, O.O., Porla, R.E. and Mandel, J.E. 1973. *Fundamental concepts in human communication*. Harper & Row, New York.
2. Barun, K.M. 2011. *Personality Development and Soft Skills*. Oxford publishers
3. Blun, A. 1996. *Teaching and Learning in Agriculture—A Guide for agricultural education.* FAO, Rome.
4. Chandrakantan, K. and Palaniswamy. 2000. *Advances in Communication Technology*. Indian Publishers
5. Dahama,O.P. and Bhatnagar,O.P.2003. *Education and communication for Development.* Oxford, IBH, New Delhi.
6. Flesche, R. 1997. *How to write, speak and think more effectively*. Harpper & Row, New York.
7. Joseph, E.H. and Alan, G. 2010 . *The Craft of Scientific Communication*. Chicago guides to writing, editing, and publishing, 240p.
8. Koprowska, K. 2008. *Communication and interpersonal skills in social work* (2nd Ed). Exeter, learning matters.
9. Lewis, A. 1990. *Beyond the facts- guide to the art of feature writing*. Surjeet publication, Delhi.
10. Ray,G.L. 1991. *Extension communication and Management*. Naya Prakash, Calcutta.
11. Raydu, C.S. 1993. *Media and Communication Management*. Himalaya Publishing House, Mumbai.
12. Roberts, D.W., Wood, D and Caspy, A. 2010. *The Development of Personality traits in adult fuood*. Gillford Press, New York.
13. Rogers, E.M. 1983. *Diffusion of Innovations*. Free Press, New York.
14. Rogers, E.M. and Shoemarker, F.F .1971. *Communication of Inovations. A Cross cultural Approach.* Free Press, New York.

4. Extn 3105 Entrepreneurship Development and Agricultural Extension Management (1+1)

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/ Agrienterprises, Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Direction and motivation Skills), POSDCoRB and principles of management, Problem solving skill, Supply chain management and Total quality management, Project Planning network analysis(PERT, CPM), MIS, MBO 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 entrepreneurship development institute and entrepreneurs.

Lecture schedule

1. Entrepreneur concept, meaning and importance
2. Entrepreneurship development: meaning and definitions, importance in the role of Indian economy, challenges.
3. Characteristics of entrepreneurship, types of enterprise, types of entrepreneurs.
4. Entrepreneurship Skills - meaning, definitions and types.
5. SWOT analysis – meaning and concept.

6,7 Entrepreneurial behavior – Entrepreneurial decision process, government policies (PESTEL factors) programmes and institutions for EDP

8. ED Process – idea generation, idea incubation, idea commercialization.
9. Business leadership (managerial grid model) - problem solving skills for entrepreneurship development.

Mid Term Examination

10. Entrepreneurship Development – Enterprise identification micro-screening.

11 Product planning and launching of enterprise – Network analysis (PERT and CPM).

12. Agri business incubators - Government and Private initiatives supply chain management-meaning and concept.
13. Management information system (MIS), management by objectives(MBO).

14,15 Total Quality Management – PDCA approach, QCC, BSC, Six Sigma- concept and importance

16. Project planning, formulation – preparation of business plan.
17. Financing of enterprise – financial appraisal of project (BCG matrix)
18. Opportunities for agri entrepreneurship and rural enterprise.

Practical schedule

1. Assessing Entrepreneurial traits
2. Assessing problem solving skills
3. Assessing managerial skills
4. Assessment of achievement motivation
5. Practical exercise on creativity, time and stress management.

6,7 Time audit through planning, monitoring and supervision – development of PERT/CPM net work.

8,9 Identification and selection of business idea - micro screening exercises.

10,11. Preparation of business plan and proposal writing, Case study on Entrepreneurs- both success and failure stories

12-14 Visit to Entrepreneurship development institutes.

15-17 Visit to successful entrepreneurs.

18 Practical Examination

Suggested Readings

1. Akhodri, N.M.P. 1989. *Trainers Manual on Developing entrepreneurial motivation*. NIES Bud, NewDelhi.
2. Bhaskaran, S. 2014. *Entrepreneurship Development and Management* .Aman Publishing House, New Delhi
3. Blanchard, H.P.K. 1985. *Management of organizational behavior Utilizing human resources*. Prentice Hall, New Delhi

4 Chatterjee, S.S. 1988. *Introduction to management, its principles and techniques*. Gold Press, Calcutta.

5. Drucker, P.F. 1964. *Managing for results*. Harper and Row, New York.

6. EDI (Entrepreneurship Development Institute of India) . 1987. *Developing New entrepreneurs*. Ahmedabad. NISIET. Libraries. 338.93/EDI

7. Goyal, D.P. 1994. *Management information system (MIS) concept applications*. Deep and Deep, New Delhi

8. Huber, G.P. 1980. *Managerial decision making*. Glenview inc. Scot Foresman.

9. Hussain, B. 1989. *Decission support system: Principles and practices*. St. Paul.West Publishing.co,

10. James, S.A.F. and Freeman,R.E. 1994. *Management*. Prentice Hall of India.Pvt. Ltd, New Delhi.

11. Khanka, S.S. 2012. *Entrepreneurial Development* .S.Chand and Company Pvt. Ltd. N

12. Rao, T.V. 1974. *Development of an entrepreneur: A behavioral model* .11M (Ahmadabad)

HOME SCIENCE

1. Hmsc 3201 Principles of Food Science and Nutrition (2+0)

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.

Lecture schedule

1-2 Terminologies used in the field of Food Science and Nutrition
3. Food- Definition, classification and importance – functions – food groups - major food constituents and their physico-chemical properties.Menu planning – Factors to be considered, balanced diet, Food pyramid
4. Recommended dietary allowances of nutrients for different age groups and sex.
5. Carbohydrates – Composition, classification, functions, sources, deficiency
6. Carbohydrates – Metabolism, Digestion and absorption
7. Proteins - Composition, classification, functions, sources, deficiency
8. Proteins - Metabolism, digestion and absorption
9. Fats - Composition, classification, functions, sources, deficiency
10. Fats – Metabolism, digestion and absorption
11. Vitamins – Fat soluble, functions, sources, deficiency
12 –13. Vitamins – water soluble and fat soluble- functions, sources, deficiency
14. Minerals – Macro minerals – Calcium, Phosphorus, Magnesium, Sodium, Potassium - functions, sources, deficiency
15–16. Minerals – Micro minerals – Iron, Zinc, Copper, Selenium, Chromium, Manganese, Iodine, Cobalt, , functions, sources, deficiency
17. Water – Functions, Regulation of water balance, Disturbances in water balance.
18. Energy – Basal Metabolism, Factors affecting BMR, Energy requirements, Thermic action of foods.

Mid Term Examination

19. Organic compounds in food – Flavours, pigments and other bioactive compounds
20. Toxicants naturally occurring in foods
21–22. Food spoilage - Common Food borne Bacteria, Moulds and yeasts. Role of microorganisms in food spoilage. Spoilage of milk, fruits and vegetables, grains and oilseeds, fish, meat and poultry.
23-24. Food borne diseases – types – definition – examples, causative organism, symptoms and prevention
25-26. Importance of food preservation, Principles and methods of food preservation – drying - dehydration – low temperature – freezing – use of chemicals – irradiation - canning
27. Malnutrition – Types - over nutrition – Obesity, under nutrition – PEM, clinical symptoms - diagnosis – Management
28-29. Nutritional problems of India – Vitamin A deficiency, anaemia, iodine deficiency - Fluorosis - Strategies to prevent micro nutrient malnutrition.
30. Food adulteration – Definition- common food adulterants – prevention

31. Food laws – Food safety and Standards Act, ISI, Agmark, ISO - HACCP – Principles, basic concept, significance
32-33. Assessment of Nutritional status of the population – Anthropometry – Biochemical – clinical – diet surveys – vital statistics
34. Nutritional programmes implemented in India
35. Nutrition Education – Objectives – Methods and tools used
36. Novel foods - Functional / Designer foods, Nutraceuticals, Symbiotics, Protein analogues.

Suggested Readings

1. Baniji, S.M., Krishnaswamy, K. and Brahmam, G. N.V. 2013. *Text book of Human Nutrition*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. *Dietary Guidelines for Indians- A Manual*. 2010. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.
3. Lal, G.,Siddappa, G.S. and Tandon, G.L. 1998. *Preservation of Fruits and Vegetables*. Published by ICAR, New Delhi.
4. *Nutrient Requirement and Recommended Dietary Allowances for Indians*. 2010. National Institute of Nutrition, Indian Council of Medical Research, New Delhi.
5. Srilakshmi, B. 2009. *Nutrition Science.* New Age International (P) Limited, Publishers, New Delhi.
6. Srilakshmi, B. 2010. *Food Science*. New Age International (P) Limited, Publishers, New Delhi.
7. Swaminathan, M. 2011. *Hand book of Food and Nutrition*. The Bangalore Printing and Publishing Company Ltd, Bangalore.

PLANT BIOTECHNOLOGY

1. Biot 2201 Fundamentals of Plant Biotechnology (2+1)

Theory

Plant Biotechnology: - concepts and applications, history of plant tissue culture, molecular biology and genetic engineering. Introduction to biomacromolecules- chemistry, structure and properties of nucleic acids, genome organization in plants. Plant tissue culture- totipotency and morphogenesis, nutritional requirements of *in vitro* cultures. Micropropagation -organogenesis and embryogenesis- different stages of micropropagation - commercial micropropagation, quality assurance of tissue culture plants. Plant tissue culture for crop improvement - haploid production, triploid production, embryo culture, *in vitro* pollination and fertilization, somaclonal variation, protoplast isolation, culture and fusion. *In vitro* germplasm conservation, *in vitro* production of secondary metabolites.
DNA modifying enzymes, blotting techniques, vectors, recombinant DNA technology, direct and indirect methods of gene transfer, transgenic plants and their applications, biosafety rules and regulations, DNA based markers, DNA fingerprinting, MAS for crop improvement. Nanobiotechnology -definition-concepts- synthesis of nano particles and characterization- biological macromolecules as nanostructures and various applications of Nanobiotechnology Bioinformatics- concepts and applications- biological databases- tools for nucleic acid data analysis – BLAST.

Practical

Requirements of a plant tissue culture laboratory-media components and preparation-sterilization techniques-inoculation of explants for organogenesis and embryogenesis, propagule multiplication, rooting, planting out and hardening/ acclimatization of regenerated plants- micropropagation of banana. Demonstration of anther culture, endosperm culture, embryo culture, embryo rescue and culture, preparation of synthetic seed, isolation of protoplast and culturing of protoplast, isolation of genomic DNA, Gel electrophoresis technique - DNA amplification through PCR, molecular marker analysis. Synthesis of nanoparticle, familiarization with various biological databases and softwares.

Lecture schedule

1. Plant biotechnology- concepts, applications, scope and importance
2. History of plant tissue culture- molecular biology and plant genetic engineering- important landmarks
3. Introduction to biomacromolecules- structure and properties of DNA
4. Structure and properties of RNA and proteins
5. Transcription, translation and the genetic code- genome organization in plants
6. Plant tissue culture-totipotency and morphogenesis-different types of culture and their applications
7. Nutritional requirements of *in vitro* culture - various basal media – macro and micro nutrients and other additives in plant tissue culture medium
8. Plant growth substances- hormonal regulations in plant tissue culture
9. Micropropagation- various routes- organogenesis/ enhanced release of axillary buds
10. Micropropagation- various routes- embryogenesis- synthetic seeds and their significance
11. Micropropagation- various stages- peculiarities of TC plants- factors influencing success in each stage
12. Commercial micropropagation- factors influencing success- problems – methods to overcome - cost of production-quality assurance of TC plants
13. Haploid production- applications and achievements
14. Triploid production- applications and achievements

15. Embryo culture, embryo rescue, invitro fertilization- applications and achievements
16. Somaclonal variation-types, reasons, use in crop improvement- *in vitro* techniques to produce stress tolerant plants
17. Protoplast isolation, culture fusion and production of somatic hybrids
18. *In vitro* germplasm conservation- short, medium and long term preservation

Mid Term Examination

19. *In vitro* production of secondary metabolites
20. DNA modifying enzymes
21. Blotting techniques- Southern, Northern and Western blot
22. Recombinant DNA technology – different steps
23. Vectors- cloning and expression vectors
24. Vectors- cloning and expression vectors
25. Gene transfer - direct and indirect methods
26. Gene transfer - selection of recombinants- markers genes, scorable and selectable markers
27. Transgenic plants and their applications
28. Biosafety rules and regulations related to GM crop research and development
29. Molecular markers - DNA based markers
30. PCR techniques , DNA finger printing
31. MAS for crop improvement
32. Nanobiotechnology- definition- concepts- Nano effect- synthesis of nanoparticles and characterization
33. Biological macromolecules as nanostructures- various applications of Nanobiotechnology
34. Bioinformatics concepts and applications
35. Biological databases – primary, secondary and structural
36. Tools for nucleic acid analysis - BLAST

Practical schedule

1. Requirements of a plant tissue culture laboratory- familiarization with different laboratories and equipment
2. Preparation of stock solutions for MS medium and stock solutions for one auxin and one cytokinin
3. Preparation of MS medium and sterilization
4. Aseptic manipulation and inoculation of various explants for different routes of micropropagation
5. Aseptic manipulation and inoculation of various explants for different routes of micropropagation
6. Subculturing of established cultures
7. Propagule multiplication
8. Rooting, planting out and hardening
9. Micropropagation of banana
10. Demonstration of anther culture, embryo culture, embryo rescue and culture
11. Preparation of synthetic seed
12. Demonstration of protoplast isolation and culture
13. Isolation of genomic DNA and quality and quantity analyses through spectrophotometry
14. DNA amplification through PCR
15. Gel electrophoresis
16. Demonstration of DNA finger printing technique
17. Synthesis of nanoparticles,familiarization with various biological databases and softwares-demonstration of BLAST analysis
18. Practical Examination

Suggested Readings

1. Attwood, T. K. and Parry-Smith, D.J. 2003. *Introduction to Bioinformatics*. Pearson Education Ltd. ISBN 81-7808-507-0, India
2. Balakrishnan, M.(Ed.). 2014. *Bioinformatics in Agriculture: Tools and Applications*. NIPA, New Delhi.
3. Bhojwani, S.S. and Razdan, S.K. 1993. *Plant tissue culture: Theory and Practice*. Elsever Science Publications, Netherlands.
4. Chawla, H.S.2012. *Introduction to plant biotechnology*. IBH publishing Co.
5. Christou, P. and Klee, H. (eds.). 2004. *Handbook of Plant Biotechnology*.Wiley, 768 p.
6. Keshavachandran, R. and Radhakrishnan, S.R. (eds.). 2015. *Agriculture Bioinformatics*. BIO-GREEN BOOKS, 444pp.
7. Smith, H.R. 2013. *Plant tissue culture –Techniques and Experiments* (third Ed). Elsevier. 188 p.
8. Singh, B. D. 2013. *Molecular biology, genetic engineering and applications of biotechnology*. Kalyani Publishers.
9. Slater, A., Scott, N. and Fowler, M. 2003. *Plant biotechnology: the genetic manipulationof plants*. Oxford University Press, 346 p.
10. Subramanian. K.S. 2015. *Nanotechnology in Agriculture*. NIPA, New Delhi.
11. Yubing Xie (ed.). 2013. *The Nanobiotechnology–hand book*. CRC press (Taylors & Francis group), London, Newyork. ISBN-13:978-1-4378-3879-9. 649 p.

FORESTRY

1. Fors 2201 Introduction to Forestry (1+0)

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 Kerala, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, plantation crop combinations, home gardens. Multi purpose trees in agroforestry, characterstics- 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 Kerala

Lecture schedule

1. Introduction – definitions of basic terms related to forestry, importance and objectives
2. Types of forests- salient features of Indian Forest Policies.
3. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers.
4-5. Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations- tree stand management
6. Agroforestry – definition and concepts- agroforestry systems prevalent in the country
7-8. Shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, plantation crop combinations-home gardens.
9. Multipurpose trees in agroforestry- characteristics

Mid Term Examination

10. Understorey components and diversification potentials
11. Component interactions- above ground and below ground interactions
12. Productive and protective functions
13. Nitrogen fixation- soil conservation
14-15. Litter dynamics and nutrient recycling
16. Carbon sequestration and climate change mitigation
17. Evaluation of agroforestry systems and agroforestry systems in Kerala
18. Social forestry – concept and importance- practices in Kerala

Suggested Readings

1. Dwivedi, A.P.1992. *Agroforestry -Principles and Practices*. Oxford and IBH Publising Co. Pvt. Ltd. New Delh,i 365p
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*. Kluwere Academic Publications, Dordrecht, The Netherlands, 499p
4. Puri, S and Panwar, P. (ed.). 2007. *Agroforestry Systems and Practices*. New India Publishing Agency, New Delhi, 643p
5. Sharma, Y.M.L.1959. *Lessons in Forestry*. ICAR, 183p
6. Singh, P., Pathak, P.S. and Roy, M.M.(ed.).1995. *Agroforestry Systems for Sustainable Land use*. SciencePublishers Inc,282p

NON GRADIAL COURSES

1. Extn 1102 Human Values & Ethics (1+0)

Theory

Values and Human values, meaning and importance in the field of agriculture and daily life. Definitions related to ethics and human values,mores, norms, folkways, beliefs, trust, perseverance, accuracy and discernment,agriculture and human values, Self explorations, its content and process, Natural acceptance and experiential validation. Understanding happiness and prosperity- a critical analysis of different philosophers. Morals and ethics, Values, Virtues, Plagiarism, Means to live peacefully in the world, Basic human aspiration, Challenges in the work place, Employer-employee reasons for unethical behaviours, Competence in professional ethics, Ethics in communication.

Lecture schedule

1 & 2	Values and Human values- meaning and importance in the field of agriculture and daily life. Definitions related to ethics and human values-mores, norms, folkways, beliefs, trust, perseverance, accuracy and discernment-agriculture and human values.
3	Self- self explorations, its content and process, Natural acceptance and experiential validation.
4 & 5	Understanding happiness and prosperity- a critical analysis of different philosophers. An appraisal of the current scenario
6	Morals and ethics- meaning definition and concepts, difference between morals and ethics. Moral dilemma versus moral autonomy
7	Values- meaning types of values- evolution of human values; value based education-its meaning and importance in personal development. Mahatma Gandhi's seven sins of the world.
8	Virtues- meaning, definition and types. Civic virtues as indispensable for a self-governing administration- category of virtues
9	Plagiarism- meaning, definition, concepts and ways of plagiarism in research and publishing. Methods to prevent plagiarism.
	Mid Term Examination
10	Means to live peacefully in the world. Factors that promote living, with internal and external peace.
11	Basic human aspiration, list of wants, basic requirements for fulfillment of human aspirations.
12	Challenges in the work place- character- meaning and types- ethics and character, education and character; ways of building character in the work place.
13	Employer-employee reasons for unethical behaviours: resource scarcity, opportunity, Attitude- Types of inquiries, in solving ethical problems- normative inquiry, conceptual inquiry, and factual or descriptive inquiry.
14	Competence in professional ethics: ability to utilize the professional competence for universalising human norms.
15 & 16	Competence in professional ethics: Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, technologies and management models- with special reference to agriculture and allied activities
17 & 18	Ethics in communication- public relations- publishing- advertising and propaganda.

Suggested Readings

1. Ashton, Q.A. 2013 . *Issues in Agricultural and Environment*. Scholarly Editions, Atlanta, Georgea.

2. Berleur, J.1996. *IFIP Framework for Ethics, Science and Engineering Ethics* (Special Issue on Global Information Ethics), **2**, 2, 155-165.
3. Bowman, J.S. and Menzel, D.C.1998 .*Teaching Ethics and Values in Public Administration Programs: Innovations, Strategies and Issues*, SUNY Press: Albany.
4. Cassuto Rothman, J.1998. *From the Front Lines, Student Cases in Social Work Ethics*. Needham Heights, MA: Allyn and Bacon.
5. Fisher,C.B. 2003. *Decoding the ethics code: a practical guide for psychologists*. Sage publications
6. Gambrill, E. and Pruger, R. (eds). 1996. *Controversial Issues in Social Work Ethics, Values, & Obligations*. Needham Heights, MA: Allyn and Bacon, Inc.
7. Govindarajan, M., Natarajan, S. and Senthikumar, V.S. 2013. *Professional Ethics and Human Value.* Prentice Hall publishers.
8. *Journal of agriculture, food and human values society*. ISSN: 0889-048X
9. *Journal of business ethics*. Springer publishers . ISSN: 0167- 4544
10. Kallman, E.A. and Grillo, J.P. 1996. Ethical *Decision Making and Information Technology: An Introduction with Cases*. McGraw Hill.
11. Kock, N.F.1999. *A Case of Academic Plagiarism- Communications of the ACM*, 42, 7, 96-104.
12. Makau, J. and Arnett, R. (eds).1997. *Communication Ethics in an Age of Diversity*. University of Illinois Press.

2. Engl.1101 Comprehension and Communication Skills in English (0+1)

Practical

Listening Comprehension: Listening to short talks lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation: rate of speech, clarity of voice, speaking and Listening, politeness &Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: testing initiative, team spirit, leadership, intellectual ability. Group Discussions.

Practical schedule

1 - 2 Listening comprehension – Short talks – Lectures – Speeches
3 -6 Oral communication – Phonetics, stress, intonation – Conversation practice
7-10 Conversation - Rate of speech – Clarity of voice – Speaking and listening – Polite conversation
11- 12 Reading skills – Reading dialogues – Rapid reading – Intensive reading – Improving reading skills
13-15 Mock interviews – Testing initiative – Team spirit – Leadership – Intellectual ability
16-17 Group discussion
19. Practical Examination

Suggested Readings

1. Lewis, N. 2009. *Word Power Made Easy*. Goyal Publishers, New Delhi .
2. Mohanraj, J. 2015. *Let Us Hear Then Speak* . Saje Publishers, New Delhi.
3. Pinker, S. 2014. *The Sense of Style : The Thinking Persons' Guide to Writing in the 21st Century* . Penguin Publishers, New York.
4. Strunk, W. and White, E.B. 1959. *The Elements of Style* . Macmillan.

3. Nsnc 1101 NSS/NCC (0+1)

Practical

Course aims at evoking social consciousness among students through various activities viz., working together, constructive and creative social work, to be skilful in executing democratic leadership, developing skill in programme development to be able for self employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical schedule

1. Introduction and basic components of NSS: Orientation
2. NSS programmes and activities
3. Understanding youth
4. Community mobilization,social harmony and national integration
5. Volunteerism and shramdan
6. Citizenship, constitution and human rights
7. Family and society
8. Importance and role of youth leadership
9. Life competencies,youth development programmes
10. Health, hygiene and sanitation,youth health, lifestyle, HIV AIDS and first aid
11. Youth and yoga
12. Vocational skill development,issues related environment
13. Disaster management
14. Entrepreneurship development
15. Formulation of production oriented project,documentation and data reporting
16. Resource mobilization
17. Additional life skills,activities directed by the Central and State Government
18. Practical Examination

4. Peyp.1201 Physical Education and Yoga Practices (0+1)

Practical

Definition and Meaning of Physical Fitness, First Aid, Track & Field, Games
Basketball, Volleyball, Football, Shuttle Badminton, Cricket, Health Related Physical Fitness Test, Concept of Yogic Practices, Asana, Pranayama, Meaning and Concepts of Meditation

Practical schedule

1. Definition and Meaning of Physical Fitness - Values of Physical Fitness - Components of Health Related Physical Fitness and Athletic related Physical Fitness – Health benefits of Physical Activity- Hypo kinetic/ life style diseases and its management.
2. First Aid - Treatment - Laceration – Blisters – Contusion - Strain – Sprain – Fracture – Dislocation and Cramps – Bandages – Types of Bandages – trapping and supports.

3-11. **Optional: Any two is to be offered according to the infrastructure facilities available**
Track & Field

i. Conditioning (warming up- jogging – free hand exercises- short sprints- cooling down)
ii. Starting and finishing techniques
iii. Jumps (long jump, triple jump and high jump)
iv. Throws (Shot put, discus throw, javelin throw, hammer throw)
v. Technique of Relay Race- Various methods of baton exchange
vi. General competition Rules of track and field events

Games

Basketball

i. Hold, passing – chest pass, bounce pass, baseball pass, overhead pass, shuffle pass
ii. Dribbling- high dribble , low dribble, zigzag dribble, figure of eight
iii. Shooting- layups, free throw and jump shot
iv. Moves- two man, three men weave
v. Tactics- Offence, defence, pivot and screening

Volleyball

i. Passing- over head and under arm
ii. Service- simple service, tennis service
iii. Lift- vertical lift, arch lift and short lift
iv. Smash and block

Football

i. Kicks - kicking with the inside of the foot, kicking with the Instep of the foot, kicking with the outer instep of the foot.
ii. Heading- from standing, from running, from jumping
iii. Throw-in
iv. Feinting: - with the lower limb, with the upper part of the body.
v. Tackling - simple block tackling, slide tackling
vi. Goalkeeping- Collection of balls, Diving
vii. Ball clearance- Kicking, throwing and deflecting

Shuttle Badminton

i. Grip – forehand and back hand
ii. Service – long service and short service
iii. Lob- Underhand and over head
iv. Overhead strokes – drop shot and smash
v. Tactics: singles and doubles

Cricket

i. Vertical bat strokes- Front foot strokes (Front foot defence, Front foot drive), Back foot strokes (Back foot defence, Back foot drive)
ii. Bowling: Types of Bowling- Basics (Grip, run up, delivery stride and follow through)
iii. Fielding: defensive fielding, attacking fielding
iv. Catching: different types of catches
v. Throwing: different types of throws
vi. Wicket keeping-basic stance, collection and stumping

Health Related Physical Fitness Test (Compulsory)

	Test Items	**Health Related Component tested**
i	One mile rum / 20m multi stage fitness test	Cardio respiratory endurance
ii	Abdominal sit-ups (60 sec)	Musculoskeletal fitness (Core)
iii	Standing broad jump	Musculoskeletal fitness (Lower body)
iv	Seated medicine ball throws (2kg)	Musculoskeletal fitness (Upper body)
v	Height and weight Body Mass Index (BMI)	Body Composition

12. **Yoga Practices :** Concept of Yogic Practices – Kinds of Yogic Practices: Asana, Pranayama, Kriya, Bandha, Murda, Dhyana.
13. Asana: Definition, Scope and Limitation of Asanas – Classification of Asanas – Meditative Asanas – Relaxative Asanas-Cultural Asanas – Step by Step Performance of Asanas - Safety Measures and Precautions.
14. Pranayama: Meaning – different Phases in Pranayama Practice: Puraka (Inhalation), Kumbhaka (Retension) and Recaka (Exhalation) – Breathing Ratio in Pranayama Practice – Application of Bandhas in Pranayama – Safety Measures and Precautions.
15. Meaning and Concepts of Meditation.
16. Practical Ecxamination

5. Etur 3101 Educational Tour I (All India)

To familarise the student with crops and other research activities of different SAUs, Research Institutes, Agro Industries, Govt. and private organisations in different parts of India. To expose the students to various national/heitage monuments as part of national integration activity (15 days duration).

6. Etur 4102 Educational Tour II (All Kerala along with RAWE)

Study tour of one week duration in the different districts of Kerala to familarise the students with the activities of different research stations of Kerala Agricultural University, other research institutes, government and private organisations in the state (One week duration)

EXPERIENTIAL LEARNING

1. Elcp. 4201 Seed Production Technology (0+10)

Practical schedule (24 weeks)

1. Seed quality- concepts and importance. Determining the mode of pollination and its importance in maintenance of genetic purity. Estimation of outcrossing, Preparation of seed album . Familiarisation of characters of KAU varieties.
2. Identification of factors causing genetic deterioration of seed and methods to safeguard genetic purity- isolation and roguing
3. Generation model of seed production and various classes of seeds. Truthfully labeled seed- Seed certification and its phases.
4. Planning of a seed production programme Practice in site selection, ensuring field standards, crop standards, familiarization of varieties, isolation distance for various crops.
5. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in rice
6. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in pulses
7. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in coconut
8. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables : tomato and brinjal
9. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables : chillies and bhindi
10. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables: vegetable cowpea, winged beans and cluster bean.
11. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables: pumpkin and ash gourd
12. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables: bitter gourd and ridge gourd
13. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables: snake gourd and bottle gourd
14. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables: cucumbers and melons
15. Seed production, harvesting at correct maturity stage, seed extraction, cleaning, drying in tropical vegetables: ornamentals.
16. Economics of seed production of different classes of seeds of important temperate vegetables (cabbage, cauliflower,).
17. Familiarization with seed processing and equipments. Planning and layout of seed processing plant.
18. Seed treatments- packaging-storage.
19. Seed enhancements- seed priming- seed coating etc.
20. Seed sampling and testing for various seed quality parameters.
21. Types of dormancy in vegetable seeds. Estimating the cost cultivation in seed production.
22. Role of physical and chemical substances in restoring seed viability. Study on factors responsible for seed germination, seedling vigour.
23. Visit to seed production, processing and packing units. Interaction with public– private entrepreneurs in seed industry.
24. Record writing, assignments, Evaluation and Practical Examination

Suggested Readings

1. Basra, A.S. 2002. *Heterosis and Hybrid Seed Production in Agronomic Crops*. CBS Publishors and Distributors, New Delhi.
2. George, R.A.T. 2009. *Vegetable Seed Production (Ed. 3).* CABI, Wallingford, UK.
3. Renugadevi, J., Srimathi, P., Ranganayaki, R.R. and Manonmani, V. 2012. *A handbook of Seed Testing.* Agribios (India).
4. Roy, B., Basu, A.K. and Mandal, A.B. 2013. *Breeding Biotechnology and Seed Production of Field Crop*s. New India Publishing Agency, New Delhi.
5. Sharma, J.P. 2011. Qua*lity Seed Production of Vegetable Crops Technological Interventions, Volume 2: Crop Specific Aspect*. Kalyani Publeshers, Ludhiana.
6. Singh, P. and Asati, B.S. 2003. *Seed Production Technology of Vegetables*. Daya Publishing House, New Delhi.
7. Singh, S.P. 2001. *Seed Production of Commercial Vegetables.* Agrotech Publishing Academy, New Delhi.
8. Verma, O.P. 2011. *Seed Production Technology of Major Crops*. Daya Publishing House, New Delhi

2. Elcp 4202 Soil, plant, water and seed testing services (0+10)

Practical schedule (24 weeks)

1-2. Introduction to analytical techniques -Volumetric analysis – Instrumental analysis
3. Soil analysis: objectives, soil sampling, Determination of soil so texture and moisture by different methods
4. Determination of physico- chemical properties of soil
5-6. Estimation of available macro nutrients in soil
7. Estimation of available micronutrients in soil
8. Interpretation of analytical data for development of fertilizer recommendation, evaluation of soil fertility and calculation of nutrient index
9. Preparation of soil saturation paste and extract and determination of EC, pH, cations (Ca, Mg, and Na) and anions(CO3, HCO3) in saturation extract
10. Water sampling techniques and tools, collection and preservation of water samples, determination of physical and chemical characteristics, total soluble and insoluble solids
11. Quality criteria, estimation of water quality parameters
12-13. Quality criteria classification and suitability of irrigation water; estimation of water quality index
14. Plant analysis- objectives, sampling of plant, stages and plant part to be sampled, CNC and CNR
15. Nutrient deficiency and toxicity symptoms in major crops
16. Dry ashing of plant material and wet digestion of plant material
17-19. Estimation of macro nutrients in plants- Data analysis and interpretation of results
20. Estimation of micro nutrients in plants- Data analysis and interpretation of results
21. Seed sampling- principles and procedures, methods of estimation of seed moisture, methods of breaking seed dormancy, determination of seed germination and seed viability
22. Seed hardening techniques and seed treatment methods
23. Seed classes - seed multiplication for various crops
24 . Visit to seed testing laboratories,Evaluation,Practical Examination

Suggested Readings

1. Biswas, T.D. and. Mukherjee, S.K. 1995.*Text Book of Soil Science* (2Nd Ed.) Tata McGraw Hill Publishing Company Limited, New Delhi

2. Chopra, S.L.and. Kanwar, J.S 1999. *Analytical Agriculture Chemistry*. Kalyani Publisher, Lucknow
3. Gupta, P. K. 2000. *Soil, Plant, Water and Fertilizer Analysis*, AgroBotanica, Bikaner
4. Jackson, M.L. 1973. *Soil Chemical Analysis*, Prentice Hall of India Pvt. Ltd., New Delhi
5. Nollet, L.M.L and De Gelder, L.S.P. 2014. *Hand Book of Water Analysis*(3rd Ed).CRC Press, London.
6. Richards, L.A. 1954. *Diagnosis and Improvement of Saline and Alkali soils. USDA Hand Book* No. 60, Washington DC, USA.
7. Sparks, D.L., Page, A.L.,.Helmke, P.A and. Loeppert, R.H. 1996.*Methods of Soil Analysis Part 3—Chemical Methods.* SSSA Book Ser. 5.3. SSSA, ASA, Madison, WI
8. Tandon, H.L.S. 1990. *Methods of Analysis of Soil, Plant, Water and Fertilizers*, FDCO, New Delhi.
9. Tisdale, W.L., Nelson. and Beaton, J.D. 1990. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York

3. Elcp. 4203 Hybrid Seed Production technology (0+10)

Practical schedule (24 weeks)

1. Breeder's kit, adaptations for selfing and crossing, determining the mode of pollination in a crop
2. Detecting apomixes and assessment of per cent out crossing
3. Familiarisation and salient features of seeds of released hybrids, types of male sterility in important cereal, pulses, oilseeds and vegetable crops
4. General techniques for production of hybrids - Selection of parents – evaluation of hybrids-. Raising parents for identifying good hybrid combinations
5. Field standards and certification in hybrid seed production
6. Techniques of emasculation, isolation and field layout for hybrid seed production

7-8. Hybrid seed production in coconut

9-10. Production of inbred lines, and parental varieties, emasculation, bagging, pollination, hybrid seed harvesting, processing and packing in rice

11. Production of inbred lines, and parental varieties, emasculation, bagging, pollination, hybrid seed harvesting, processing and packing in bhindi

12-13. Production of inbred lines, and parental varieties, emasculation, bagging, pollination, hybrid seed harvesting, processing and packing in leguminous crops

14-15. Production of inbred lines, and parental varieties, emasculation, bagging, pollination, hybrid seed harvesting, processing and packing in solanaceous vegetables.

15-16. Production of inbred lines, and parental varieties, emasculation, bagging, pollination, hybrid seed harvesting, processing and packing in cucurbitaceous vegetables

16-17. Production of inbred lines, and parental varieties, emasculation, bagging, pollination, hybrid seed harvesting, processing and packing cool season vegetables

17-18. Hybrid seed production in Orchids & Anthurium

19. Harvesting indices and seed extraction
20. Seed drying and processing; cleaning-upgrading, seed treatment and packaging
21. Visit to seed processing and packing units.
22. Visit to hybrid seed production farms
23. Economics of hybrid seed production
24. Record writing, assignments, Evaluation,Practical Examination

Suggested Readings

1. Agarwal, R.L. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.
2. Basra, A.S. 2000. *Heterosis and Hybrid Seed Production in Agricultural Crops*. Food Product Press.

3. Chhabra, A.K. 2006. *Practical Manual of Floral Biology of Crop Plants*. Dept. of Plant Breeding CCS HAU, Hisar.
4. Desai, B.B., Katecha, P.M. and Salunke, D.K.1997. *Seed Hand Book: Biology,Production, Processing and Storage*. Marcel Dekker.
5. Desai, B.B. 2004. *Seeds Handbook.* Marcel Dekker.
6. George, R.A.T. 1980. *Vegetable Seed Technology. A Technical Guide toVegetable Seed Production, Processing, Storage and QualityControl.* FAO, Rome.
7. Hartman, H.T. and Kester, D.E. 2000. *Plant Propagation: Principles andPractices*. Prentice Hall.
8. Kelly, A.F. and George, R.A.T. (Eds.).1998. *Encyclopedia of Seed Production ofWorld Crops*. John Wiley & Sons.
9. Kelly, A.F. 1988. *Seed Production of Agricultural Crops*. John Wiley.
10. Mc Donald, M.B. and Copeland, L.O. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
11. Poehlman, J.M and Sleper, D.A. 2006. *Breeding Field Crops*. Blackwell.
12. Salunkhe, D.K., Desai, B.B. and Bhat, RN. 1987. *Vegetable and Flower Seed Production*. Agricole Publ. Academy.
13. Singh, B.D. 2005. *Plant Breeding: Principles and Methods*. Kalyani.
14. Singh, S.P. 2001. *Seed Production of Commercial Vegetables*.Agrotech.
15. Singhal, N.C. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.
16. Thompson, J.R. 1979. *An Introduction to Seed Technology*. Leonard Hill.
17. Tunwar, N.S and Singh, S.V. 1985. *Handbook of Cultivars*. CSCB, GOI.
18. Vanagamudi, K., Prabhu, M., Kalaivani, S., Bhaskaran, M. and Manonmani, V. 2010. *Vegetable Hybrid Seed Production and Management*. Agribios (India).

4. Elcp 4204 Agriculture Waste Management (0+10)

Practical schedule (24 weeks)

1	Introduction – agricultural wastes – source segregation methods -methods of collection and storage of agricultural wastes
2 -3	Survey of different agricultural production systems – observe types of wastes generated – quantification and classification of wastes – methods of waste processing - reporting
4 -5	Visit to a Landfill site – Study about volume, size and Chemical reduction techniques - leachate treatment facilities – assessment of pollution problems - Garbage to Green – Converting landfills to parks
6	Composting –principles - factors affecting composting- different methods of composting- aerobic - windrow compost preparation - aerated static pile composting
7-8	Other methods of composting – preparation of different types of compost –-Sheet composting –In vessel composting – biodynamic composting - pipe composting
9	Preparation of compost by trench method- NADEP compost - anaerobic composting –- merits- demerits
10	Use of micro organisms in composting - Microbial composts –EM compost - Preparation of Coir pith compost - production technologies
11-12	Preparation of Vermi compost - mass multiplication of earthworms- indoor vermicomposting (small scale) - outdoor vermicomposting (commercial scale)- insitu vermicomposting.
13	Rapid thermo chemical processing of agricultural wastes- Pyrolysis -Biochar production by the process of pyrolysis from organic waste
14	Biogas plants – different types – designs – visit to nearby biogas production unit and study the operation and production of biogas –advantages – disadvantages - prepare lay out plan
15	Visit to the Bioethanol production plant at CTCRI – Use of agricultural wastes in preparation of bio fertilizers
16	Value addition of products - enriched manures - production with biotic and abiotic components

17 Liquid organic manures- vermiwash, compost tea, biogas slurry- preparation - enrichment and uses – Other uses of agricultural wastes

18 Evaluation of compost maturity - maturity indices of compost- Determinations - C:N ratio, temperature, colour, odour moisture content, pH, EC

19 Rapid test for assessing compost maturity- nutrient contents (N,P, K, Ca, Mg, Fe, Mn, Zn,Cu)

20 Rapid test for assessing compost maturity (contd)- microbial load, detection of pathogens and hazardous heavy metals (Ni, Pb, Cd, As, Hg)

21 Compost stability test-microbial respiration of CO_2- germination test

22 Quality parameters of organic manures and specifications - procedure for collection of manure samples- solid and liquid manures

23-24 Preparation of project proposal and work plan for establishing commercial organic manures production unit- report preparation, presentation,Evaluation and Practical Examination

Suggested Readings

1. Ashworth, G.S. and Azevedo, P. 2009. *Agricultural Wastes*. Nova Science Publishers
2. Cheng, H. H (ed.). 1990. *Pesticides in the Soil Environment: Processes, Impacts, and Modeling*. SSSA-ASA, Inc., Madison, WI.
3. Das, P.C. 1993. *Manures and Fertilizers*. Kalyani Publishers, New Delhi.
4. Gupta P.K. 2006. *Vermi composting for Sustainable Agriculture*. Published by AGROBIOS (India) Jodhpur
5. Powers, J. F. and Dick, W.P. 2000. *Land Application of Agricultural, Industrial, and Municipal By-products.* SSSA-ASA, Inc., Madison, WI.
6. Ramachandra T.V. 2006. *Soil and Groundwater Pollution from Agricultural Activities.* Commonwealth Of Learning, Canada and Indian Institute of Science,Bangalore
7. Rattan Lal (ed).2001. *Soil carbon sequestration and the greenhouse effect*. SSSA Special publication number 57, SSSA Inc . Madison, WI.
8. Sharma, A.K. 2005. *Biofertilizers for Sustainable Agriculture* .Published by AGROBIOS (India) Jodhpur
9. Stoffella, P. J. and Khan, B.A (ed.). 2001. *Compost Utilization in Horticultural Cropping Systems*. Lewis Publishers, Boca Raton, FL.
10. Tandon, H.L.S. 1992. *Fertilizers, Organic Manures, Recyclable Wastes and Biofertilizers*. Fertilizer Development and Consultation Organization
11. Tandon, H.L.S. 1993. *Method*s *of Analysis of Soils, Plants, Waters and Fertilizers*. Fertilizer Development and Consultation Organization.143p.
12. Yawalkar, K.S., Agrawal, J.P. and Bokde,S. 1981. *Manures and Fertilizers*. Agri-Horticultural Publishing House, Nagpur, India pp 398

5. Elcp 4205 Organic Production Technology (0+10)

Practical schedule (24 weeks)

1. Introduction – different types of organic manures- Enriched organic manure
2. Methods of composting - preparation of coir pith compost and vermicompost
3. Liquid organic manures- vermiwash, compost tea, biogas slurry- preparation - enrichment and uses.
4. Liquid organic manures- panchagavya, dasagavya, fish amino acid, egg amino acid, jeevamirthum- preparation and uses
5. Studies on biofertilizers and application for different crops
6. Mass multiplication of azolla and its uses

7-8. Raising green manure and cover crops

9. Studies on biocontrol agents- preparation and application

10. Organic certification- organic materials for use as fertilizer and soil amendments -packaging, labelling and marketing of organic manures
11-16. Organic production of vegetables- leafy vegetable, cucurbitaceous vegetable, leguminous vegetables, solanaceous vegetable,bhindi, cool season vegetables
17-20. Organic production of vegetables in grow bags on house terrace
21-23. Organic production of vegetable crops in polyhouses
24. Preparation of project proposal and work plan for establishing organic farm and manure production unit- report preparation, presentation,Evaluation and Practical Examination.

Suggested Readings

1. Ananthakrishnan, T.N. (ed.) 1992. *Emerging Trends in Biological Control of Phytophagous insects.*Oxford & IBH, New Delhi.
2. Chhonkar, P.K. and Dwivedi, B.S. 2004. Organic farming and its implications on India's food security. *Fertil. News* 49(11): 15-18,21-28,31&38.
3. Gaur, A.C. 1982. *A Manual of Rural Composting*. FAO/UNDP Regional Project Document, FAO, Rome.
4. KAU, 2009. *The Adhoc Package of Practices Recommendations for organic farming*. Kerala Agricultural.University, Thrissur ,360 p.
5. Lampin, N. 1990.*Organic Farming*.Farming Press Books, Ipswitch, U.K.
6. Palaniappan, S.P and Anandurai, K. 1999. *Organic Farming- Theory and Practice*, Scientific Pub., Jodhpur.
7. Reddy, M.V. (ed.) 1995.*Soil organism and Litter decomposition in the Tropics.* Oxford & IBH, New Delhi.
8. Singh, S.P. (ed.) 1994. *Technology for Production of Natural Enemies*, Project Directorate of Biological Control, Bangalore.
9. Trewavas, A. 2004. A critical assessment of organic farming and food assertions with particular respect to UK and the potential environmental benefits of no-till agriculture.*Crop Prot.* 23:757-781.
10. Trivedi, R.N. 1993.*A Text Book of Environmental Sciences*, Anmol Pub., New Delhi.
11. Veeresh, G.K., Shivashankar, K. and Singlachar, M.A. 1997. *Organic Farming and Sustainable Agriculture,* Association for Promotion of Organic Farming, Bangalore.
12. Woomer, PL. and Swift, M.J. 1994. *The Biological Management of Tropical Soil Fertility,*.S.B.F. & Wiley.

6. Elcp 4206 Quality Assurance of Manures, Fertilizers and Agrochemicals (0+10)

Practical schedule (24 weeks)

1 Introduction to agrochemicals-Classification and Types – Role in soil fertility management-identification of different types on manures, fertilizers and agrochemicals
2 Preparation of vermicompost, coirpith compost, liquid manures- Panchagavya, Dashagavya , Fish Amino acid, Jeevamirthum, Beejamirtham-Deoiled cakes
3 Sampling of manures- Analysis of quality parameters of different manures – physical properties- Bulk Density, Particle density,moisture content, maturity indices- colour, texture,
4 Analysis of physico- chemical characteristics- pH, EC, Organic Carbon, total Nitrogen, phosphorus and potash
5 Analysis of physico- chemical characteristics- Heavy metals, micronutrients
6 -7 Biological Parameters (Manures)- enumeration of beneficial microflora, enzyme status – Dehydrogenase , respiratory quotient – Co_2 evolution rate , Biomass Carbon
8 Comparison of quality standards of different manures with FCO,1985
Enrichment techniques of manures
9 Sampling of fertilizers for analysis- physical properties – moisture content, hygroscopicity and moisture content
10 Qualitative tests for the identification of different fertilizer radicals.

11 Analysis of nitrogenous fertilizers- Urea, ammonium nitrate,ammonium sulphate
12 Analysis of phosphotic fertilizers-Rock phosphate, Single super phosphate
13 Analysis of potassic fertilizer- MOP, Sulphate of potash,
14 Analysis of micronutrient fertilizers – Chelates, method of application of different fertilizers
15 Liming materials – $CaCO_3$, $CaSo_4$- Determination of neutralizing value
16 Specifications of Fertilizer control Order- FCO 1985- comparison of standards of different fertilizers-
17 Pesticides- Sampling techniques and safe handling, classification and role in agriculture and allied sectors- identification of various formulations in markets
18 Insecticides – organic & inorganic, Organochlorine insecticide- Determination of ai HCH, DDT
19 Insecticides- Organophosphorus groups- Determination of ai in Malathion
20 Fungicides-Copper group -Estimation of ai in Copper Oxy chloride, Thiram, Ziram
21 Fungicides-Sulphur group- Estimation of ai- Sulphur dust
22 Herbicides- new generation herbicides- Determination of ai in Glyphosate,2,4 D
23 Calculation of doses of pesticides , fate of pesticides, Residues
24 Botanical pesticides- Preparation methods,Evaluation,Practical Examination

Suggested Readings

1. Buchel, K.H. 1977. *Chemistry of Pesticides*. John Wiley and Sons, Newyork
2. FCO.1985. (As amended up to November 2013) .2013. Fertilizer Association of India, New Delhi
3. Gupta, P.K. 1999. *Hand book of Soil, Fertilizer and Manure*. Agro Botanica, Bikaner
4. Palaniaapan, S .P. and Annadurai, K .2007. *Organic farming : Theory and Practice*.2007. Scientific Publishers. Jodhpur
5. Sreeramalu, U.S.1979.*Chemistry of Insecticides and Fungicides.* Oxford & IBH Publishing Co, New Delhi
6. Tandon, H.L.S. 1992. *Fertilizers, Organic manures, Recyclable Wastes and Biofertilizers.* FDCO, New Delhi

7. Elcp 4207 Commercial Production of Seeds of Pulses and Forage Legumes (0+10)

Practical schedule (24 weeks)

1-2 Planning and layout of seed production plots of cowpea, green gram, black gram, and red. gram.
3-4. Preparation of land and basal application of manures and fertilizers.
5-8. Pre-sowing seed treatments – Rhiozobium inoculation and sowing
9-12. Cultural and nutrient management including top dressing and foliar spray of nutrients.
13-15. Timely after care operations at various growth stages.
16-18. Pest and disease management and adoption of appropriate measure.
19-20. Determination of physiological maturity and harvesting. Management of different methods of threshing and drying.
21-22. Processing, treating, packaging, labeling, sealing, storing, etc., as per minimum certification standards and procedures. Seed testing. Management of storage pests by different seed treatment methods –fungicides / insecticides / botanicals, etc. Management of seed store sanitation.
23-24. Cost benefit analysis- economics of seed production. Preparation of balance sheet – income and cash flow statement. Identification of market channels and estimation marketing costs and margins. Report writing on activities undertaken, Evaluation,Practical Examination.

Suggested Readings

1. Balasuramaniyan, P. and Palaniappan, S.P. 2003. *Principles and Practices of Agronomy*. Agrobios(India)
2. KAU [Kerala Agricultural University].2016. *Package of Practices Recommendations – Crops.* Directorate of Extension, Kerala Agricultural University, Thrissur
3. Prasad, R. (ed.). 2001. *Field Crop Production*. ICAR, New Delhi
4. Singh,C., Singh, P., and Singh, R. 2003. *Modern Techniques of Raising Field Crops* (2nd Ed.). Oxford & IBH Publishing Co , New Delhi.
5. Yadav, D.S. 1992. *Pulse Crops*. Kalyani Publishers., New Delhi.

8. Elcp 4208 Seed and Seedling Production of Vegetables (0+10)

Practical schedule (24 weeks)

1 Orientation and preparation of the project on the identified activities- vegetable seed and seedling production
2 Identification of vegetable seeds and varietal characterization, Estimation of seed requirement of various vegetable crops
3 Familiarisation of types of media, methods of sterilization; seed treatment methods ; Procurement of growing media, portrays /nursery bags, tools and implements etc.
4 Protray seedling production- Soil sterilization, seed treatment and sowing in portrays
5 Field standards like isolation distance and rouging
6 Land preparation and sowing of cucurbits - bittergourd, snakegourd and vellari etc.
7 Land preparation and sowing of leguminous vegetables
8 Land preparation and sowing of okra and amaranthus
9 Land preparation, and planting of chilli, brinjal, tomato
10 Protray seedling production- Soil sterilization, seed treatment and sowing in protrays
11 Weeding fertilizer application and trailing of cucurbits - bittergourd, snakegourd and vellari etc.
12 Weeding, fertilizer application and aftercare of chilli, brinjal, tomato
13 Weeding , fertilizer application and aftercare of leguminous vegetables okra and amaranthus
14 Protray seedling production- Soil sterilization, seed treatment and sowing in protrays
15 Harvesting, Threshing; Seed Extraction techniques in cucurbits
16 Harvesting, Threshing; Seed Extraction techniques in leguminous vegetables
17 Harvesting, Threshing; Seed Extraction techniques in okra and amaranthus
18 Seed processing- drying, cleaning, grading and moisture testing of cucurbits
19 Seed processing- drying, cleaning, grading and moisture testing of chilli, brinjal, tomato
20 Seed processing- drying, cleaning, grading and moisture testing of leguminous vegetables okra and amaranthus
21 Packaging , storage and marketing of seeds
22 Seed germination and viability testing, vigour testing (Electrical conductivity, Accelerated Ageing, Mean Germination Time, Vigor Index) Seed Quality enhancement (pelleting, priming, hardening, fortification, coating)
23 Visit to commercial vegetable seed production fields and seed testing laboratories
24 Maintenance of seed production record, Working out economics of seed and portray seedling production; documentation and report writing,Evaluation,Practical Examination

Suggested Readings

1. Agrawal, P.K. (ed.). 1993. *Handbook of Seed Testing*. Ministry of Agriculture, GOI, ND.
2. Agrawal, R.L. 1996. *Seed Technology*. Oxford & IBH Publishing Co., New Delhi.
3. Anon, 1965. *Field Inspection Manual and Minimum Seed Certification Standards*, NSC Publication, New Delhi.

4. Arya, P.S.1995. *Vegetable seed production principles*. Kalyani Publishers. New Delhi. Copeland LO & McDonald MB. 2001. Principles of Seed Science and Technology. 4 th Ed. Chapman & Hall.
5. Bhaskaran, M. A.,Bharathi, K.,Vanangamudi, N., Natarajan, P., Natesan, R., Jerlin and Prabakar, K. 2003. *Principles of seed production*. Kaisher Graphics, Coimbatore.
7. Ramalingam, C. K., Sivasubramnaiam and Vijayakumar, A. 1997. *A guide to seed legislation*. Rassi Computers, Madurai.
7. Raymond, A.T. George. 1985. Vegetable seed production. Longman and London, New York.
8. Singhal, N.C. 2003. *Hybrid Seed Production in Field Crops*. Kalyani Publishers, New Delhi.
9. Singh, S.P.1999. *Seed production of commercial vegetables*. Kalyani Publishers. New Delhi.
10. Tunwar, N.S.and Singh, S.V. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

9. Elht 4201 Floriculture and Landscaping (0+10)

Practical schedule (24 weeks)

1 Components of landscape gardens
2 -3 Identification of ornamental plants, their functional uses
4-5 Propagation of ornamental plants
6-7 Cultural practices of ornamental plants
8 Introduction to annuals and biennials in the garden
9-10 Preparation of seed beds nurseries and portrays for propagation of annuals
11-13 Annuals and biennials: Preparation of flower beds, borders and carpet beds
14 Herbaceous perennial: Propagation and production of plants
15 Lawn making and maintenance
16 Potting and repotting. Arrangement of potted plants for trophy and indoor decoration,
17 Hedges and edges; making and maintenance
18 Ornamental trees and shrubs: identification and production of seedlings
19 Orchids and anthuriums ; propagation and production of plants
20 Identification of tools and implements and their practices
21 Training and pruning, topiary
22 Making miniature gardens: tray gardens, dish gardens, fairy gardens, butterfly gardens, bottle gardens, kokedema : string garden
23 Laying out formal and informal gardens, vertical gardens, water gardens , rose garden and special gardens.
24 Visit to different types of gardens,Evaluation,Practical Examination

Suggested Readings

1. Bose, T.K., Maiti, R.G, Dhua, R.S.and Das, P. 1999. *Floriculture and Landscaping*. Naya Prokash.
2. Lauria, A.and Victor, H.R. 2001. *Floriculture – Fundamentals and Practices* .Agrobios.
3. Nambisan, K.M.P.1992. *Design Elements of Landscape Gardening* . Oxford & IBH.
4. Randhawa, G.S.and Mukhopadhyay, A. 1986. Floriculture in India . Allied Publ.
5. Sabina GT & Peter KV. 2008. Ornamental Plants for Gardens . New India Publ. Agency.
6. Valsalakumari et al. 2008. Flowering Trees . New India Publ. Agency.
7. Woodrow MG.1999. Gardening in India. Biotech Books.

10. Elht.4202. Food Processing and Food safety standards (0+10)

Practical schedule (24 weeks)

1. Market survey, assessment, analysis- Familiarization with processed products- Packaging and labeling.
2. Preliminary processing of fruits and vegetables and storage.
3-4. Commercial preparation of fruit and vegetable beverages (squash/syrup/cordial/RTS beverage)
5-6. Preparation of solid and semi-solid fruit and vegetable products (jam, jelly, marmalade, Preserves, candies and crystallized fruits)
7-8. Preparation of Fermented products- (wine, vinegar etc.)
9-10. Vegetable based products (tomato products, ashgourd candy, pickles etc)
11-12. Byproduct and waste utilization, Dehydrated and Intermediate Moisture Food products, Fortified processed products – Functional foods and neutraceuticals
13 -14. Subsidiary fruit products viz., cheese, halwa, toffee, leather, amchur etc.-
15. Minimal Processing
16. Novel processing technologies for industrial production
17. Value added coconut products
18. Spice powders and curry powders-spice extracts
19. Cocoa and cashew products
20. Value addition in flower crops- Flowers as food
21. Processing of cereals and pulses
22. Value addition of tuber crops, Baked and confectionery food items.
23. Quality control and safety regulation of processed food products- Conduct and interpretation of sensory analysis, Project preparation for small scale units and industrial fruit processing units
24. Visit to processing units, Farmers' co-operatives, Food Parks and exporting units, Evaluation,Practical Examination.

Suggested Readings

1. Rajarathnam, S and Ramteke, R.S.2011.Advances in preservation and processing technologies of fruits and vegetables.New India Publishing Agency, New Delhi
2. Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products Tata Mc. Graw Hill Publishing Company, New Delhi.P.1112
3. Saraswathy, S., Preeti, J.L., Balasubramanyan, S., Suresh, J., Revathy, N. and Natarajan, S. 2008. Post harvest management of horticultural crops. AGRIBIOS (India).
4. Sharma, S.K.2010. Post harvest management and processing of fruits and vegetables- Instant Notes. New India Publishing Agency. New Delhi.390.
5. Srivastava, R.P and Sanjeev Kumar.2007. Fruit and vegetable preservation: Principles and Practices. International Book Distributing Company, Lucknow.474.
6. Sudheer, K.P. & Indira ,V 2007. PostHarvest Technology of Horticultural Crops. New India. Publ. Agency.
7. Verma L.R and Joshi V.K.2000. Postharvest technology of fruits and vegetables- Generalconcepts and principles. Vol I & II.

11. Elht. 4203. Commercial Vegetable Production (0+10)

Practical schedule (24 weeks)

1. Familiarisation of characters of different vegetable crops and their varieties
2. Nutritional value of vegetables- calculation of ANV, carrying capacity

3. Seed and soil treatments- chemical treatments, soil sterilization, Seed bio priming
4. Preparation of nursery bed, sowing and aftercare of transplanted vegetables
5. Protray seedling production- types of portrays, media, sowing and aftercare of seedlings
6. Preparation of calendar of operations; Calculation of requirement of inputs-seed, fertilizers etc.
7. Main field preparation and planting of transplanted vegetables- Formation of beds, ridges and furrows, application of manures and basal dressing of fertilizers, gap filling –tomato
8. Main field preparation and planting of transplanted vegetables- Formation of beds, ridges and furrows, application of manures and basal dressing of fertilizers, gap filling –brinjal
9. Main field preparation and planting of transplanted vegetables- Formation of beds, ridges and furrows, application of manures and basal dressing of fertilizers, gap filling –chillies
10. Main field preparation and planting of transplanted vegetables- Formation of beds, ridges and furrows, application of manures and basal dressing of fertilizers, gap filling –amaranthus
11. Main field preparation and planting of transplanted vegetables- Formation of beds, ridges and furrows, application of manures and basal dressing of fertilizers, gap filling –okra
12. Main field preparation and planting of cucurbits- Formation of pits, application of manures and basal dressing of fertilizers, gap filling
13. Main field preparation and planting of cucurbits- Formation of pits, application of manures and basal dressing of fertilizers, gap filling
14. Main field preparation and planting of cowpea and other leguminous vegetables- Formation of pits/ ridges and furrows, application of manures and basal dressing of fertilizers,gap filling
15. Main field preparation and planting of cowpea and other leguminous vegetables- Formation of pits/ ridges and furrows, application of manures and basal dressing of fertilizers, gap filling
16. Main field preparation and planting of okra- Formation of ridges and furrows, application of manures and basal dressing of fertilizers, gap filling
17. Precision farming- Irrigation scheduling, fertigation
18. Inter cultivation operations- Top dressing of fertilizers and earthing up, preparation of growth regulator solutions and application, training and pruning, staking etc.
19. Plant protection- Preparation and application of pesticides/ fungicides/ botanicals, mechanical control, setting up of traps
20. Maturity indices and harvesting of vegetables for vegetable purpose
21. Maturity indices and harvesting of vegetables for seed purpose
22. Seed extraction methods, processing and storage markets.
23. Marketing of vegetables- marketing channels- wholesale markets and retail markets
24. Economics of vegetable cultivation, Evaluation,Practical Examination

Suggested Readings

1. Bose, T. K. et al.,. 2002. Vegetable Crops. Naya Prokash, Calcutta.
2. Das, P. C.1993. Vegetable crops in India.Kalyani Publishers
3. Hazra, P. and Som, M. G. 1999. Technology for vegetable Production and Improvement. Naya Prokash, Calcutta
4. Thamburaj, S. and Singh, N. 2005. Vegetables, tuber crops and spices. ICAR, New Delhi.

12. Elht 4204 Nursery Management (0+10)

Practical schedule (24 weeks)

1. Introduction, familiarization of nursery activities, Records and registers, preparation of inventory.Survey of nursery business and marketing potential in Kerala
2. Familiarisation with growing media components, their proportions, containers and implements.
3. Seed propagation - collection, treatment and processing for sowing – seed viability and seed testing for germination

4. Seed bed preparation, sowing in beds, pots, preparation of media and potting mixtures for spices, plantation crops, medicinal and aromatic crops.
5. Establishment of mother plant block for progeny development, mother palm / tree selection
6. Seed nut selection and seed storage.
7. Nursery bed preparation, sowing and seedling selection.
8. Practicing different methods of vegetative propagation followed in plantation crops, spices, medicinal and aromatic crops like grafting, budding, layering, etc.
9. Maintenance of the planting materials of plantation crops, spices, medicinal and aromatic crops produced and their proper management in the nursery.
10. Propagation through tissue culture in plantation crops, spices, medicinal and aromatic crops and raising of primary and secondary nurseries.
11. Preparation of project proposal and work plan for establishing a commercial nursery in plantation crops, spices, medicinal and aromatic crops .
12. Report writing, demonstration of tangible outcome and final presentation and evaluation.
13. Preparation of nursery beds and sowing seeds of annuals and tree crops, preparation of portrays.
14. Preparation of nursery beds for planting cuttings, preparation of cuttings of ornamental shrubs and passion fruit
15. Preparation of rootstocks for budding roses.
16. Propagation of plants by different types of leaf cuttings.
17. Care and management of mother plants: Irrigation, training, pruning, fertilizer application, plant protection (need based).
18. Application of plant growthregulators : Applicationof rooting hormone, Rootex to cuttings of different ornamental plants and planting.
19. Pre- curing of shoots of ornamental plants for air layering.
20. Propagation of monopodial orchids by stem cuttings.
21. Propagation of sympodial orchids through pseudobulbs
22. Selection of seedlings of ornamentals sown in nursery beds and protrays. Propagation of sympodial orchids through kiekies. Propagation of anthurium by suckers and stem discs. Propagation of lovilovi, guava and west Indian cherry by air layering.
23. Propagation of gladiolus through corms.Propagation of chrysanthemum through suckers.
24. Propagation of rose through T – Budding. Propagation of mango and jack by grafting. Propagation of breadfruit and cassia through root cutting. Propagation of other plants like lilies (bulbs), heliconia , canna and *Hedichium* (rhizomes) through specialized plant parts, Evaluation,Practical Examination.

Suggested Readings

1. Balasimha, D and Rajagopal, V.2004. Arecanut, CPCRI, Kasagod, Kerala.
2. Chadha.K.L. 2001. Hand book of Horticulture, ICAR, New Delhi.
3. Dashora, L.K., Dashora, A., and Lakhawat, S.S. 2006. Production technology of plantation crops, spices, aromatic and medicinal plants. Agrotech publishing academy, Udaipur, 352p
4. Kumar, N. 2003. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
5. Menon.K.P.V and Pandalai.K.M.1960.The Coconut Palm- a monograph.Indian Central Coconut Committee ,Ernakulam.
6. Pruthi, J.S. Minor spices and condiments: crop management and post-harvest technology.Directorate of information and publications of agriculture, New Delhi, 782p
7. Shanmugavelu, K.G. and Kumar, N. 2002. Production technology of spices and plantation crops. Agrobios, India, 546p

13. Elpt. 4201 – Bioagents and Biofertilizer production (0 + 10)

Practical schedule (24 weeks)

1. Basic insectary facilities, familiarization of equipment and other infrastructure used in production aspects, techniques on mass rearing and release of parasitoids. Assessment of predatory potential of natural enemies, demand assessment of bioagents.
2-3. Mass production, formulation, quality assessment and sale of *Beauveria bassiana, Metarhizium anisopliae* and *Lecanicillium lecanii*
4. Production and sales of cue lure and methyl eugenol traps– working out cost and returns of products
5. Botanical pesticides, preparation and use .Familiarisation with commercial formulation of biopesticides and their evaluation. .
6-7. Familiarisation of biocontrol agents of plant parasitic nematodes, entomopathogenic nematodes for insect pest management.
8-9. Familiarisation with equipment and accessories used for mass culturing and production of biocontrol agents of plant parasitic nematodes.
10. Mass culturing and formulation of *Bacillus macerans*, mass culture of greater wax moth, *Galleria melonella* for mass culturing of entomopathogenic nematodes.
11. Mass culturing of *Heterorhabditis* sp. and *Steinernema* sp.
12. Preparation of media, isolation of antagonists from soil and foliage, screening for pathogen suppression- mass multiplication and application
13-15. Indigenous organic preparations- Panchagavya, Dasagavya, Fish amino acid, Egg amino acid, Jeevamrita, Compost-Tea: Preparation, *in vivo* studies against important plant pathogens
16. Compatibility of organic preparations/fungicides with effective biocontrol agents
17. Evaluation of botanicals against viral diseases: Bougainvillea, *Phyllanthus* sp.
18-19 Mass culturing and formulation of bioagents, packing and labeling, shelf life and bioefficacy studies. Estimation of cost and returns. Identification of market channels.
20-21. Biofertilizers-media preparation, isolation (*Rhizobium* sp., *Azospirillum* sp., *Azotobacter*, P soubilizers, AMF, K solubilizers, etc.), consortium of biofertilizer agents
22. Mass production and application methods, packing and labeling, shelf life studies.
23. Estimation of cost and returns. Identification of market channels.
24. Report preparation, Evaluation, Practical Examination.

Suggested Readings

1. Arathy, R. 2014. Management of collar rot and Web blight of cowpea with composts and compost tea . MSc (thesis) KAU, Thrissur, 71 p.
2. Butt, M. T., Jackson, C. and Magan, N (eds.) Fungi as biocontrol agents. CAB International, Willingford, U. K., 390 p.
3. Gaugler, R. and Kaya, H. K. 1990. Entomopathogenic Nematodes for the Biological control of Insects. CRC Press, BoCA Raton, Florida, pp. 93-115
4. KAU, 2009. The Adhoc Package of Practices Recommendations for organic farming. Kerala Agricultural. University, Thrissur, 360 p.
5. Pelczar, M. J., Chan, E. C. S., and Krieg, N. R. 1986. Microbiology. Tata Mc Graw- Hill Publishing Company, Ltd, New Delhi, 926 p.
6. Ravichandra, N. G. 2010. Methods and Techniques in Plant Nematology. PHI Learning Pvt. Ltd. New Delhi, 616p.
7. Singh, S. P.1995. Technology for Production of Natural enemies. Project Directorate of Biological Control, ICAR, 221p.
8. Sudharma, K. Biological Control of Crop Pests and weeds. 2011. Kerala Agricultural University, 214 p.
9. Tanada and Kaya, H. K. 1993. Insect Pathology. Academic Press, 666 p.

10. Weinert, E. J, Miller, S. A., Ikeda, D. M, Chang , K. C. S. , Mc Ginn , J. M. and Du Ponte, M . W. 2014. Natural farming Fish amino acid . Sustainable Agriculture, University of Hawai, College of Tropical Agriculture and Human resources, Honlulu, 104 p.

14. Elpt 4202 – Mushroom Cultivation (0+10)

Practical schedule (24weeks)

1 Introduction to the world of mushrooms
2 Familiarization of different edible mushrooms, poisonous, hallucinogenic and medicinal mushrooms
3 Preparation of solid and liquid media
4 Isolation and pure culturing
5 Preparation of spawn (mother spawn and commercial spawn)
6 Inoculation of spawn and incubation
7 Different types of spawn and packing
8 Collection and cultivation of different mushrooms (*Pleurotus,Calocybe,Volvariella,*)
9 Collection and cultivation of different mushrooms (contd.)
10 Purchase of chemicals, containers and raw materials for sterilization
11 Sterilization of substrates for bed preparation
12 Oyster mushroom bed preparation using different substrates
13 Milky mushroom bed preparation
14 Preparation of casing materials and casing of laid out beds
15 After care of mushrooms – pest and disease management
16 Mushroom house design
17 Harvesting, packaging and marketing mushrooms and mushroom products
18 Processing of harvested mushrooms and value addition
19 Preparation of spawn for coirpith composting
20 Procuring coirpith from nearby centres
21 Composting of coirpith
22 Packing of coirpith compost
23 Marketing of coirpith compost
24 Visit on mushroom enterprises for familiarisation of activities,Evaluation,Practical Examination

Suggested Readings

1. Advances in Horticulture Vol.XIII Chadha, K. L. & Sharma, S. R. 2001.Malhothra Publication House, New Delhi.

2. Ahlawat O.P. and Tewari R.P. 2007. Cultivation technology of paddy straw mushroom (*Volvariellavolvacea*) Technical Bulletin- National Research Centre for Mushroom (Indian Council of Agricultural Research) Chambaghat, Solan-173 213 ,HP

3. Chadha K L & Sharma S R. 2001.Advances in Horticulture (Mushroom). Vol. XIII. Malhotra Publ. House, New Delhi.

4. Chang S T & Hayes W A. 1997.The Biology and Cultivation of Edible Mushrooms. Academic Press, New York.

5. Chang S T & Miles P G. 2002.Edible Mushrooms and their Cultivation. CRC Press, Florida..

6. Dhar B L. 2005. Cultivation Technology of High Temperature Tolerant White Button Mushroom. DIPA, ICAR, New Delhi.

15. Elpt. 4203 Beekeeping (0 + 10)

Practical schedule (24 weeks)

1-2. Identification of different bees, hives, bee castes, brood and food storage pattern in the comb.
3. Visit to apiaries and apiary establishment.
4. Acquaintance with bee keeping equipments.
5. Visit to the manufacturing unit of bee hives and other beekeeping equipments.
6-7. Domestication of feral colonies.
8-10. Seasonal management of Indian bee colonies
11. Colony division and artificial queen rearing.
12. Identification of pests and diseases of bees and their management.
13-15. Meliponiculture
16. Hive based products, techniques for extraction.
17-18. Preparation of value added products of honey.
19. Quality analysis of honey.
20-21. Melissopalynology.
22. Visit to beekeepers units.
23-24. Preparation of project proposal, report preparation, Evaluation, Practical Examination.

Suggested Readings

1. Abrol. D. P. 2003. Honey bee diseases and their management. Kalyani Publishers
2. Joy M. Grahnm.1999. The Hive and the Honey Bee. Dadant ansd Sons. Hamilton, Illinois,1324p.
3. Mishra, R. C. 1995. Honeybees and their management in India. ICAR, NewDelhi. 168p.
4. Mishra, R. C. 1998. Perspectives in Indian apiculture. Agrobotanica. 412p.

16. Elpt 4204 Detection and Management of plant pathogens (0+10)

Practical schedule (24 weeks)

1. Symptomatology of diseases caused by fungi, bacteria, virus, viroids and phytoplasma
2. Dry and wet preservation of diseased specimen samples
3. Familiarisation of various equipments used in plant pathology
4. Preparation of media for culturing and different stains and staining of fungi and bacteria
5. Isolation and inoculation of proving Kochs' postulates of plant pathogenic fungi and bacteria
6. Cultural and morphological studies for identification of plant pathogenic fungus
7. Cultural and physiological studies for identification of plant pathogenic bacteria
8. Slide culture techniques , micrometry, spore counting with haemocytometer, microphotography
9. Isolation of microorganisms from phyllosphere and rhizosphere- Dual culture technique-screening bacterial and fungal biocontrol agents -preparation of bio fungicides and bioinoculants
10. Familiarisation of fungicides in the market -field visit-trade name-common name and preparation of fungicides: Bordeaux mixture, Bordeaux paste and Cheshunt compound
11. Fungicides and antibiotics for plant disease management-contact-systemic-new generation-antibiotics common name-trade name -mode of action –dose and calculation
12. Acquaintance with Plant protection equipments , their operation and repair and fungicide application methods
13. Survey and surveillance of diseases - assessment and forecasting

14. Microscopic examination and identification of inclusion bodies and preparation of buffers for isolation of plant virus
15. Mechanical, seed, graft, dodder and insect transmission of plant viruses. Local lesion assay for the detection of plant viruses .
16. Purification of plant virus and differential centrifugation
17. Acquaintance with gel electrophoresis: SDS-PAGE, Native PAGE and Staining of gels
18. Production of antiserum- maintenance of small animals – different routes of injections – bleeding of animals – purification of IgG from blood samples Preservation and storage of antiserum
19. Immunoassay of plant virus : Micro-precipitation technique, ELISA, Dot blot immunobinding assay (DIBA)
20. Electron microscopy – field visit to RGCB – Immunosorbent Electron microscopy
21. Molecular detection – familiarisation of equipments for Nucleic acid based detection of plant pathogen –PCR, IC-PCR, RT-PCR
22. Integrated management of representative fungal, bacterial and viral diseases
23. Preparation of tissue culture media and meristem culture and virus indexing - mass multiplication disease free planting materials
24. Isolation and purification of antiviral principles from plants – testing for its efficacy, Evaluation,Practical Examination

Suggested Readings

1. Ahlawat, Y. S., Ramachandran, P., Niazi, F. R., and Chakraborty, N. K. 2001.*Characterisation of Viruses and diagnosis of Viral diseases of Plants*. Indian Agricultural Research Institute, New Delhi. 50p.
2. Alexopoulous, C. J., Mims, C. W., and Blackwell, M. 2014. *Introductory Mycology* (4th Ed.).Johnwiley and sons Ltd., New York. 869p
3. Dube, H. C. 2012. *Introduction to Fungi*.Scientific publishers, Jodhpur. 603p.
4. Hull, R. 2014. *Plant Virology* (5th Ed.).Academic press, California. 1104p.
5. Jayaraman, J. and Verma, J. P. 2002.*Fundamentals of Plant Bacteriology* (Reprint, 2015).Kalyani publishers, New Delhi.
6. Mandal, B., Roy, A., and Baranwal, V. K. 2014.A Practical Manual of Plant Virology. Indian Agricultural Research Institute, New Delhi. 110p.
7. Sachdev, A., Balasubrahmanyam, A., Johari, R. P., and Lodha, M. L. 2000.*Advanced Techniques in Plant Biochemistry and Molecular Biology*. Indian Agricultural Research Institute, New Delhi. 47p.
8. Schadd, N. W. 1992. *Laboratory Guide for Identification of Plant Pathogenic Bacteria*.International book publishing cooperative, Lucknow.
9. Tripathi, D. P. 2006. *Introductory Mycology*.Kalyani publishers, Ludhiana. 481p.
10. Tripathi, D. P. 2008. *Introductory Plant Bacteriology* (Reprint, 2013).Kalyani publishers, New Delhi.
11. Tripathi, D. P. 2011. Introductory Plant Virology (2nd Ed)Kalyani publishers,NewDelhi 532 p.
12. Walkey, D. G. 1991. Applied Plant Virology (2nd Ed.). Springer, 352p.
13. Webster, J. and Weber, R. 2007. Introduction to Fungi (3rd Ed.).Cambridge university press, England. 846p.

17. Elab 4201 Agri-business management (0+10)

Practical schedule (24 weeks)

1 Registration, orientation and placement
2-4 Attachment training with Agro- Based Industries and preparation of report
5-7 Attachment training for studying the management of Agricultural Allied

8-10 Attachment training for studying Post- Harvest Management of Agricultural
11-14 Business plan preparation
15-16 Detailed acquaintance on accounting and book keeping Records and accounting
17 Survey on retail markets
18-19 Supply chain analysis
20-21 Agricultural food laws and licensing policies
22 Acquaintance on export trade
23-24 Final project preparation and presentation,Evaluation,Practical Examination

Suggested Readings

1. Alagumani, T., Chinnaiyan, P., Elangovan, S. 1998. *Agricultural Management* Publishers K9 International, Madurai.
2. Downey, W.D., Troche, J.K.1981. *Agribusiness Management*. Mc Graw Hill Inc., New Delhi
3. Gittinger, J.P. 1982. *Economic Analysis of Agricultural Projects*. The Johns Hopkins University Press, Baltimore
4. Philip, K. 2004. *Marketing Management*. Prentice Hall, New Delhi

18. Elss 4201 Agro- Advisory Services (0+10)

Practical schedule (24 weeks)

1. Agro advisory Service Concept - meaning, importance, principles techniques of data generation – observant and non observant techniques – orientation on primary and secondary data – its nature, characteristics, source.
2 Inventerisation of agro advisory services – different techniques of inventorisation, group formation of students and group exercise on inventorisation of seed to seed inputs and services.
3 Attachment training of student group with different agro service agencies (Institutions like IF, Vellayani, Sangamaithri, KVK Mithraniketan and Selected Pvt Nurseries)
4 - 5 Participatory Rural Appraisal- tools & techniques theoretical orientation and in house practice session
6 - 7 Conduct of PRA at selected village – identification of need in Agro advisory service – Report preparation, presentation and fine tuning of report with farmer participation
8 - 9 Development of projects on agro advisory services in liaison with Instructional Farm based on data generated through PRA, conduct of field consultancy at the selected village, with multi disciplinary – inter institutional support.
10 - 12 Conduct of Agro Clinics at selected area (3 Clinics)
13 - 14 Organizing need based on campus/off campus training programmes.
15 - 16 Conducting consultancy service on Peri Urban farming with special focus on roof top farming.
17 - 19 Exposure visit to successful farm units, Modal market centers – presentation and report preparation of field exposure visits.
20 - 21 Orientation of students to ICT based market extension service.
22- 24 Report preparation, presentation by students, evaluation, reconsideration and final report presentation, Evaluation,Practical Examination

Suggested Readings

1. Adhikary, M.M., Sarkar, A., Acharia,S.K. and Basu, D. 2006. Participatory Planning and Project Management in Extension Sciences Agrotech Publishing Company, Udhaipur.

2. De, Dipak, 2011 A handbook of Extension education, JV Publishing House, Jodhpur
3. Samanta,R.K and Chandra Gowda 2002 KVK- The Capacity Builder of Farmers, New Delhi, B.R. Publishing Corporation
4. Samanta,R.K. 1991, Agricultural Extension in Changing World Perspective, New Delhi, Uppal Publishing House.

19. Elss 4202 Agricultural Information Support Services (0+10)

Practical schedule (24 weeks)

1 -2 Experiential learning-relevance and Practical importance developing better training skills, Introduction to print and electronic media-Agricultural Publications, books, booklets, folder. Brochure, circular, writing news stories, feature stories-writing for specialized magazines

3 - 5 Writing scripts for Radio and Television in different formats. Advertising based on target audience, media and geographic area conceptualization comprehension and duration-translation of ideas into campaign-adverting campaign from conception to execution

6 -7 Data base management and organization of bio resources

8- 9 Hands on experience in production of information materials in agriculture and allied sectors required for Print, electronic media, TV.

10-12 Web designing Computer graphics, Computer Animations, Computer Aided design, Hands on experience in computer graphics – Graphic functions – colour selection and application design of animation sequence –computer aided design – presentation graphics – computer assistant visualization .

13-14 Cyber extension tools their applications, Introduction with computer hardware and software, KIOSK Format and software integration.

15 Hands on experience in media production and digital photography – Photo feature, Editing photos – Digital Cameras. Digital films, getting prints and accessories –handling movie cameras, Angle of filming, length of scenes , editing the films.

16-17 Visit to IIITMK and similar institutes

18-20 ICT application, Agri clinics and its tools for agriculture and information delivery systems. Writing for farm families-Agricultural publications, books, booklets, folder, brochure, circular, writing news stories, feature stories-writing for specialized magazines.

21-23 Data base management and organization of bio diversity. ICT application, Agri clinics and its tools for agriculture and information delivery systems (continued) Hands on experience in media production and digital photography – Photo feature, Editing photos – Digital Cameras. Digital films, getting prints and accessories –handling movie cameras, Angle of filming, length of scenes , Editing the films. (continued)

24 Communicating articles for publishing in Print medium, recording of Radio & Television Programme. Experience sharing of Experiential Learning,Evaluation,Practical Examination

Suggested Readings

1. Alexander Lewis, 1990 Beyond the facts, A guide to the art of feature writing. Delhi, Surjeet publication.
2. Applebaum.R.L., Anaatol, K.W.E., Hays, E.R.Jensan, O.O., Porla, R.E.Mandel,J.E. 1973. Fundamental concepts in human communication. Harper & Row, New York.
3. Berlo, D.K. 1960. The process of communication. Holt, Rinehart and Winston, New York.
4. Blun,A., 1996. Teaching and Learning in Agriculture—A Guide for agricultural education, FAO,Rome.
5. Chandrakantan,K. and Palaniswamy 2000. Advances in Communication Technology, Indian Publishers

6. Dahama,O.P. and Bhatnagar.O.P.2003 Education and communication for Development. Oxford, IBH, New Delhi.
7. Flesche,R. 1997 How to write, speak and think more effectively. Harpper & Row, New York.
8. Ray,G.L. 1991 Extension communication and Management Naya Prakash, Calcutta.
9. Raydu, C.S. 1993.Media and Communication Management, Himalaya Publishing House, Mumbai.
10. Rogers, E.M. 1983. Diffusion of Innovations. Free Press, New York.
11. Rogers, E.M. and Shoemarker, F.F 1971, Communication of Inovations. A Cross cultural Approach, Free Press, New York.

20. Elbt 4201 Tissue culture technologies (0+10)

Practical schedule (24 weeks)

1. Familiarization with Plant Tissue Culture Laboratory facilities, keeping of records, accounts of plant tissue culture, Collection of literature on available micropropagation protocols, quality assurance of TC plants – NCS-TCP.
2. Market survey, financial implications of commercial tissue culture facility, collection of details on cost of lab equipment, chemicals, glass wares and other required items, preparation of work plan
3. Procurement of chemicals, glass wares, disinfectants etc. disinfection and sterilization of glass wares, collection and maintenance of explant source
4. Preparation of stock solutions for tissue culture media, plant tissue culture media preparation and sterilization
5. Culture establishment of banana and virus indexing of established sprouts
6. Culture establishment of orchids and anthurium
7. Subculturing of established cultures
8. Subculturing of established cultures
9. Propagule multiplication in banana/orchids/ anthurium
10. Propagule multiplication in banana/orchids/ anthurium
11. Propagule multiplication in banana/orchids/ anthurium
12. Propagule multiplication in banana/orchids/ anthurium
13. Propagule multiplication in banana/orchids/ anthurium
14. Propagule multiplication in banana/orchids/ anthurium
15. Induction of rooting
16. Induction of rooting
17. Hardening of in vitro regenerated plantlets
18. Hardening of in vitro regenerated plantlets
19. Hardening of in vitro regenerated plantlets
20. Clonal fidelity analysis
21. Virus indexing of 0.1 per cent regenerated plantlets of banana
22. Marketing of TC plants
23. Visit to commercial micropropagation unit.
24. Report submission, Evaluation,Practical Examination

Suggested Readings

1. Bhojwani S.S. and Razdan S.K. 1993. Plant tissue culture: Theory and Practice. Elsevier Science Publications, Netherlands.
2. Chawla H.S. . 2012. Introduction to plant biotechnology. IBH publishing Co.
3. Roberta H.Smith .2013. Plant tissue culture –Techniques and Experiments (third edition) Elsevier. 188 pp

21. Elbt 4202 Molecular Diagnostics (0+10)

Practical schedule (24 weeks)

1. Plant genomic DNA isolation
2. Quantity and quality check of isolated DNA
3. Agarose gel electrophoresis
4. RNase treatment for obtaining quality DNA
5. Mining the gene sequences from databases, alignment and analysis
6. Primer designing for the genes of interest
7. DNA profiling using RAPD and ISSR
8. SSR marker systems, genome analysis using reported primers for the traits of interest
9. Clonal fidelity analysis using the RAPD and ISSR marker systems
10. Development of SCAR markers for trait of interest and validation of scar markers
11. Isolation of DNA of pathogenic organisms
12. Isolation of fungal RNA
13. PCR techniques for detection of races
14. Isolation of mRNA from total RNA
15. Quantification and characterization of mRNA
16. cDNA synthesis
17. cDNA synthesis continued
18. RT-PCR
19. Protein based methods – Total protein isolation
20. ELISA
21. Dot blot analysis
22. Western blotting
23. Detection of genetically modified crops and detection of transgene contamination in non-GM crops
24. Report submission,Evaluation, Practical Examination

Suggested Readings

1. David E. Bruns, Edward R. Ashwood, Carl A. Burtis 2007. Fundamentals of Molecular Diagnostics, Elsevier publications
2. Neil Boonham, Jenny Tomlinson, Rick Mumford. 2016 Molecular Methods in Plant Disease Diagnostics: Principles and Protocols