Semester IV

Course No.	Courses	Credit		
		T	**P**	**Total**
A)	**Core Course**			
AGRO246	Crop Production Technology-II (Rabi crops)	1	1	2
AGRO 247	Farming System and Sustainable Agriculture	1	0	1
AGRO 248	Principles of Organic Farming	1	1	2
AHDS 242	Livestock Breeding and Nutrition	1	1	2
ECON 242	Agriculture Finance and Cooperation	2	1	3
ENGG 243	Renewable Energy and Green Technology	1	1	2
ENTO 243	Pest of Horticultural Crops and their Management	1	1	2
GPB 243	Principles of Seed Technology	1	2	3
HORT 243	Production Technology for Fruit and Plantation Crops	1	1	2
SSAC 242	Problematic Soils and their Management	1	1	2
	Subtotal	**11**	**10**	**21**
B)	**Elective Courses (3 credits)**			
ELE BOT 242	Micropropogation Technologies	1	2	3
ELE EXTN 244	Agricultural Journalism	2	1	3
ELE GPB 244	Commercial Plant breeding	1	2	3
ELE PATH 243	Bio-fertilizers, Bio-control Agents and Bio-pesticides	2	1	3
	Subtotal Elective	**1**	**2**	**3**
C)	**Non-Gradial Course**			
EDNT 242	Study Tour*	0	1	1
	Total Credits (A+B+C)	**12**	**13**	**25**

* Educational Tour shall be organized after completion of Sem.IV and before start of Sem.V

Course :	*AGRO 246*		***Credit:***	*2(1+1)*	***Semester-IV***
Course title:	*Crop Production Technology-II (Rabi crops)*				

Syllabus

Theory : Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals –wheat and barley, **Rabi Sorghum* and maize*,** pulses-chickpea, lentil, peas, **French bean*** oilseeds-rapeseed, mustard and sunflower; **Safflower*, linseed*** sugar crops-sugarcane; **Sugar beet*,** medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops-berseem, Lucerne, oat., m**aize* and sorghum* and other crops –Tobacco* and sweet potato***

Practical : Sowing methods of wheat and sugarcane, identification of weeds in *rabi*season crops, study of morphological characteristics of *rabi* crops, study of yield contributing characters of *rabi* season crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of *rabi* crops at experimental farms. Study of *rabi* forage experiments, oil extraction of medicinal crops, visit to research stations of related crops. **Mechanization in crop cultivation of *kharif*crops.***

(Note : * new inclusion)

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1 - 5	Cereals – Wheat, sorghum, barley and maize (grain corn, sweet corn and baby corn)	30
6-8	Pulses – Chickpea, lentil, pea, French bean	15
9-12	Oilseeds – Sunflower, safflower mustard and linseed	25
13	Sugar crop – Sugarcane and sugar beet	10
14-15	Other crops – Potato, tobacco and sweet potato	10
16-18	Forage crops – Lucerne, berseem, maize, oat and sorghum	10

b) Practical

Experiment	Topic
1	Sowing methods of wheat
2	Sowing method of sugarcane,
3	Identification of weeds in rabi season crops,
4&5	Study of morphological characteristics of rabi crops

Experiment	**Topic**
6	Calculations of plant population, seed rate and fertilizers doses.
7&8	Study of yield contributing characters of rabi season crops
9	Study of yield and juice quality analysis of sugarcane
10 & 11	Study of important agronomic experiments of rabi crops at experimental farms.
12	Study of rabi forage experiments
13 &14	Oil extraction of medicinal crops
15	Visit to research stations of related crops.

Suggested Readings:

1. *Modern technique of raising field crops by Chiddasingh*
2. *Agronomy of field crop by S.R. Reddy*
3. *Hand book of Agriculture, ICAR New Delhi*

Course :	*AGRO 247*		***Credit:***	*1(1+0)*	***Semester-IV***
Course title:	*Farming System and Sustainable Agriculture*				

Syllabus

Theory: Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

Teaching Schedule

Theory

Lecture	Topic	Weightage (%)
1-2	Farming systems – Definition, scope, concept and objective of Farming Systems,.	8
3	Classification of Farming systems and factors affecting it.	4
4	Study of different components of Farming System and their maintenance	8
5-6	Definition of Cropping systems, cropping pattern, Multiple cropping systems and its classification, advantages and disadvantages.	8
7	Study of efficient Cropping systems and allied enterprises.	4
8& 9	Assessment tools for determining production and efficiencies in cropping systems and farming systems (Based on land use efficiency, biological potential and economic criteria).	12
10 & 11	Sustainable Agriculture: Definition, Principles, Goals, Problems and its importance in Agriculture, Sustainability Index and Conservation Agriculture	10
12	Impact of LEIA (Low External Input Agriculture) and HEIA (High External Input Agriculture) on crop productivity and sustainable agriculture.	8
13	Integrated Farming System, historical background, characteristics, objectives, components and its advantages.	10
14	Development of site specific IFS models for different Agro climatic zones, its resource use efficiency and optimization technique	10
15	Farming systems in relation to environment, its resource cycling and flow of energy	10
16	Visit to various IFS models.	8

Suggested Readings:

1) Cropping systems Theory and Practice -Chatterjee B.N. and Maiti S.
2) Cropping Systems in Tropics – Principles and practices. -Palanniappan S.P.

Course :	*AGRO 248*		***Credit:***	*2(1+1)*	***Semester-IV***
Course title:	*Principles of Organic Farming*				

Syllabus

Theory: Organic farming, principles and its scope in India; Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

Practical : Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management; Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling**.**

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	Organic Farming, Definition, Principles and its Scope in India and world	9
2 &3	Initiative taken by Govt, NGO and Organizations for promotion of Organic Agriculture	10
4	Organic ecosystem and their concepts	7
5	Organic nutrient, resources and its fortification	8
6	Restriction to Nutrient use in Organic Farming	8
7	Choice of Crops and Varieties in Organic Farming	8
8 & 9	Fundamentals of insect pest and disease management under organic mode of production	7
10	Weed Management in Organic mode of Production	8
11	Operational structure of NPOP	5
12 & 13	Certification process and Standards of Organic Farming	10
14 & 15	Processing, Labeling and Economic consideration and its viability in Organic production	10
16	Export potential of Organic products	10

b) Practical

Experiment	Topic Details
1.	Visit to Organic Farm to study the various components and their utilization
2.	Study of Preparation methods for Enriched compost.
3.	Study of Preparation methods for Vermicompost and vermiwash.
4.	Study of biofertilizers and bio-inoculants
5.	Study of preparation of Biodynamic compost and cow pat pit
6.	Study of quality analysis of compost and vermicompost.
7.	Study of crop residue management and green manuring
8 & 9.	Study of indigenous technology knowledge (ITK) for nutrient, insect, disease and weed management.
10.	Study the method of preparation and Production cost of *Panchagavya, Beejamrut*and *Jeevamrut*in Organic farming
11.	Study the method of preparation and Production cost of *Dashparni, Neem Seed extract,* in Organic farming
12&13.	Study of post-harvest management in Organic Farming.
14 & 15.	Study of Quality aspects : Grading, Packing, Handling.
16.	Visit to Biocontrol Laboratory and Biofertilizer and vermicompost Unit

Suggested Readings:

1) Organic Farming for Sustainable Agriculture by Dahama A. K. Agrobios Publication.
2) Organic Farming: Theory and Practices by Palanippan, S.P. and Anaadurai, K.
3) Organic Farming in India, Problems and Prospects byThapa, U. and Tripathi, P.
4) Trends in Organic Farming in India by Agrobios Publication
5) Handbook of Organic Farming.
6) Recent Developments in Organic farming by Gulati and Barik

Course :	*GPB 243*		***Credit:***	*3(2+1)*	***Semester-IV***
Course title:	*Principles of Seed Technology*				

Syllabus

Theory

Seed and seed technology: introduction, definition and importance. Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed. Foundation and certified seed production of important **cereals, pulses, oilseeds, fodder and vegetables**. Seed certification, phases of certification, procedure for seed certification, field inspection. Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Varietal Identification through Grow Out

Test and Electrophoresis, Molecular and Biochemical test. Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production.

Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing. 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.

Practical

Seed production in major cereals: Wheat, Rice, Maize, Sorghum, Bajra and Ragi. Seed production in major pulses: Urd, Mung, Pigeonpea, Lentil, Gram, Field bean, pea. Seed production in major oilseeds: Soybean, Sunflower, Rapeseed, Groundnut and Mustard. Seed production in important vegetable crops. Seed sampling and testing: Physical purity, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: Grow out test and electrophoresis. Seed certification: Procedure, Field inspection, Preparation of field inspection report. Visit to seed production farms, seed testing laboratories and seed processing plant.

Teaching Schedule

a) Theory

Lecture	Topic	Weightages (%)
1	Seed and seed technology : introduction, definition and importance	5
2	Deterioration causes of crop varieties and their control & Maintenance of genetic purity during seed production	5
3	Seed quality : definition. Characters of good quality seed	4
4	Different classes of seed.	4
5	Foundation and certified seed production of important cereals **(Wheat, Sorghum, Maize, Rice &Bajara)**	5
6	Foundation and certified seed production of important pulses **(Pigeon Pea, Green Gram, Black Gram & Chick Pea)**	5
7	Foundation and certified seed production of important oil seeds **(Soybean, Sunflower, Safflower ,Groundnut and Cotton)**	5
8	Foundation and certified seed production of important fodder crops **(Fodder Sorghum, Lucern, Berseem,)**	5
9	Foundation and certified seed production of important vegetable crops **(Tomato, Brinjal, Chilli, Onion & Okra)**	5
10	Seed certification, phases of certification, procedure for seed certification, field inspection	4
11	Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds control order 1983.	5
12	Varietal identification through Grow Out Test and Electrophoresis.	15

Lecture	Topic	Weightages (%)
	Molecular and biochemical test. Detection of genetically modified crops. Transgene contamination in non-GM crops, GM crops and organic seed production.	
13	Seed drying, processing and their steps. Seed testing for quality assessment.	5
14 & 15	Seed treatment, its importance, method of application and seed packing. Seed storage : general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage	14
16	Seed marketing : structure and organization, sales generation activities ,promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing.	14
	Total	100

b) Practical

Experiment	Topic
1	Seed production in major cereals : Wheat and Rice
2	Seed production in : Sorghum and Bajara
3	Seed production in : Maize.
4	Seed production in major pulses : Green gram and Black gram
5	Seed production in pulses : Pigeonpea and Lentil
6	Seed production in pulses : Gram and Field pea
7	Seed production in major oil Seeds : Soybean, Rapeseed & Mustard
8	Seed production in major vegetable crops :Brinjal and Tomato.
9	Seed production in vegetable crops :Chilli and Okra.
10	Seed production in vegetable crops : Onion
11	Seed production in : Pumpkin, Bottle gourd
12	Seed production in : Bitter gourd, Ridge gourd, Sponge gourd
13	Seed sampling and testing procedure
14	Physical purity test
15	Seed moisture test
16	Germination test – types of germination
17	Germination test – different methods of germination
18	Seed viability test
19	Seed and seedling vigour test
20	Genetic purity test : Grow Out Test
21	Genetic purity test : Electrophoresis
22	Seed certification : Procedure
23	Field inspection, preparation of field inspection report
24	Visit to seed production farms of cereal crops
25	Visit to seed production farms of oilseed crops

Experiment	Topic
26	Visit to seed production farms of pulse crops
27	Visit to seed production farms of fiber crops
28	Visit to seed testing laboratories
29 & 30	Visit to seed processing plant

Suggested Readings:

Sr. No	Title of Book	Author/Authors	Publisher
1.	Seed Technology	R. L. Agrawal	Oxford and IBH. Publishing Company , New Delhi.
2.	Seed Science and Technology	SubirSen N Ghosh	Kalyani Publication New Delhi
3.	Principles of Seed Technology	Phundan Singh	KalyaniPublication New Delhi.
4.	Seed Science and Technology	N. C. Singhal	KalyaniPublication New Delhi.
5.	Seed Technology	DhirenderKhare and Mohan Bhale	Scientifice Publishers, JodhaPur
6.	Vegetable Seed Production	Nempal Singh, D.K. Singh, Y.K. Singh and Virendirekumar	International Book Distribution Company, Lucknow.

Course :	*ELE GPB 244*		***Credit:***	*3(1+2)*	***Semester-IV***
Course title:	*Commercial Plant Breeding*				

Syllabus

Theory

Types of crops and modes of plant reproduction.Line development and maintenance breeding in self and cross pollinated crops (A/B/R and two line system) for development of hybrids and seed production.Genetic purity test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line and cultivars: haploid inducer, tissue culture techniques and biotechnological tools. IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act. Variety testing, release and notification systems in India. Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Techniques of seed production in self and cross pollinated crops using A/B/R and two line system. Learning techniques in hybrid seed production using male-sterility in field crops. Understanding the difficulties in hybrid seed production, Tools and techniques for optimizing hybrid seed production. Concept of rouging in seed production plot.Concept of line its multiplication and purification in hybrid seed production.Role of pollinators in hybrid seed production.Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops.Sampling and analytical procedures for purity testing and detection of spurious seed. Seed drying and storage structure in quality seed management. Screening techniques during seed processing viz., grading and packaging. Visit to public private seed production and processing plants.

Teaching Schedule

a) Theory

Lecture	Topics to be covered	Weightage (%)
1.	Types of Crop: Classifications of crops.	4
2-3	Male sterility-Definition, Transfer of MS to a new strain, maintenance of MS, Production of hybrid seed and limitations in using male sterility systems.	12
4-5	Hybrid varieties & features, Development of hybrid varieties: Development and evaluation of inbred lines, selection of productive inbred lines & production of hybrid seeds. Maintenance of nucleus & breeder seed in self and cross pollinated crops, Maintenance of pre-released or newly released varieties; Breeder seed of established varieties, Maintenance of nucleus & breeder seed of inbred lines.	14
6	Genetic purity test of commercial hybrids: Maintenance of genetic purity and safeguards for maintenance of genetic purity, Factor affecting genetic purity.	6
7-9	Advances in hybrid seed production of Rice, Sorghum, Maize, Perl-millet, Sunflower, Cotton, Pigeon-pea, etc. Steps and factor affecting hybrid seed production.	20
10	Principles of quality seed production of vegetables crops under open and protected environment	6
11	Development of parental lines and cultivars: Haploid production by anther and pollen culture.	8
12	IPR issue in commercial plant breeding	2
13-14	DUS testing -The Protection of Plant Varieties and Farmer's Right Act, 2001 (PPVFR, 2001): Main objective, Power and duties of PPV & FR Authority, Criteria for protection, Registration, Plant varieties qualifying for registration and Compulsory licensing. DUS testing centers.	10
15	Variety testing, release and notification major steps in India, General procedure for variety testing. Central Variety Release Committee, State Variety Release Committee. Seed production organizations; NSC, MSSC.	10

Lecture	Topics to be covered	Weightage (%)
16	Genetic and Agronomic principles of quality seed production and its characteristics	8
Total		**100**

b) Practical

Experiment	Title
1.	Floral Biology in self pollinated species
2.	Floral Biology in cross pollinated species
3	Selfing techniques in different crops
4.	Crossing techniques in different crops
5.	Learning techniques in hybrid seed production using male-sterility in fields crops
6.	Techniques of seed production using A, B and R systems in self pollinated crops.
7.	Techniques of seed production using A, B and R systems in cross pollinated crops.
8	Techniques of seed production using two line systems in self and cross pollinated crops.
9	Problems in hybrid seed production.
10	Tools and Techniques for optimizing hybrid seed production
11	Multiplication and purification of line in hybrid seed production
12	Rouging concept in seed production plot
13	Role of pollinators in hybrid seed production
14-17	Hybrid seed production techniques in field crops: Sorghum, pearl-millet, maize, rice, sunflower, pigeon-pea, cotton crops.
18-20	Hybrid seed production techniques in vegetable crops: Okra, Brinjal, Onion, Chilli, tomato etc.
21	Seed sampling.
22	Physical purity test and detection of spurious seed.
23	Genetic purity test under field and laboratory conditions.
24	Seed drying
25	Storage structure in quality seed management
26	Seed screening techniques during seed processing: Seed grading
27	Seed screening techniques during seed processing :Seed packaging

Experiment	Title
28-29	Visit to public / private seed production plots
30-31	Visit to public / private seed processing plants
32	Economics of commercial seed production

Suggested Readings:

1) *Hybrid Seed Production in Field Crops: Principles and Practices by N. C. Singhal, 2003,*
a. *Kalyani publication, Delhi*
2) *Principles of Seed Technology by P.K. Agrawal, 2002, Oxford*
3) *Seed Production of Vegetables. By Prabhakar Singh and B. S. Asati*
4) *Seed Technology, 1996, Agarwal R L, Oxford*
5) *Plant Breeding; Principles and Methods by B.D. Singh, 2006, Kalyani publication, Delhi*
6) *Genetics 2002 by P. K. Gupta, Rastogi publication*
7) *An Introduction to Seed Technology by Thomson J.R.*
8) *Seed science and technology laboratory manual, 1997 by M. B. Mdonald and L.O.*
9) *Copeland, Chapman & hill.*
10) *Seed Technology by DhirendraKhare and Mohan S. B. Bhale, 2005*
11) *Principles and practices of plant breeding by Sharma J. R.1984, Tata McGraw –Hill.*
12) *Practical plant breeding by Gupta S. K. 2004, Agribios publication*
13) *Principles of Vegetable Seed Production by Prem Narayan*
14) *Principles Plant Breeding, 1981 by Allard R W, Jhon Willy and sons*
15) *Fundamentals of Plant Breeding, 2005 Kalyani publication, Delhi*
16) *Fundamentals of Plant Breeding & hybrid seed production, 1996, Agarwal R L, Oxford*

Course :	*ELE BOT 242*		***Credit:***	*3(1+2)*	***Semester-IV***
Course title:	*Micro-propagation Technologies*				

Syllabus

Theory

Introduction, History, Advantages and limitations; Types of cultures (seed, embryo, organ, callus, cell), Stages of micropropagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture),Organogenesis (callus and direct organ formation), Somatic embryogenesis, cell suspension cultures, Production of secondary metabolites,Somaclonal variation, Cryopreservation

Practical

Identification and use of equipments in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for explants, Preparation of stocks and working solution, Preparation of working medium, Culturing of explants:Seeds, shoot tip and single node, Callus induction, Induction of somatic embryos regeneration of whole plants from different explants, Hardening procedures.

Teaching Schedules

a) Theory

Lecture	Topic	Weightages (%)
1 & 2	Meaning and concept of *in vitro* culture and micro-propagation, Historical milestones.	05
3	Tissue culture methodology: Sterile techniques	10
4	Synthetic and natural media components, growth regulators, environmental requirement.	10
5	Totipotency, dedifferentiation;genetic control of regeneration;	05
6	Plant regeneration pathways - Organogenesis and Somatic embryogenesis;	10
7	Organogenesis- Purpose, methods and requirements for organogenesis, indirect and direct organogenesis;	10
8, 9 & 10	Somatic embryogenesis- Procedures and requirements for organogenesis, indirect and direct embryogenesis; Differences between somatic and gametic embryogenesis,	15
11, 12 & 13	Micro-propagation- Definition, methods, stages of micro-propagation and its significance; Advancement and future prospects of micro-propagation.	20
14 & 15	Micropropagation - Axillary bud proliferation approach- Shoot tip and meristem culture;	10
16	Synthetic seed- Concepts, necessity, procedure and requirements for production of synthetic seeds.	5
	Total	**100**

b) Practical

Experiment	Topic
1	Laboratory organization of Plant Tissue Culture Laboratory
2	Safety Measures in Laboratory
3, 4, 5	Sterilization techniques: Common Contaminant in Laboratory, Sterilization of glassware, Working of Laminar air flow cabinet
6, 7	Culture Media: Definition, Components of Media, Stock Solution, Working Solution, Sterilization of Media.

8, 9	Preparation and sterilization of growth regulators/thermolabile compounds.
10,11	Preparation of working medium
12,13	Experimentation on determining optimum concentration of growth regulators.
14	Sterilization techniques for explants.
15, 16, 17, 18	Callus induction from different parts of plants
19, 20, 21, 22	Regeneration of whole plants from induced callus using different parts of plants.
23, 24	Induction of somatic embryos.
25, 26	Experiments of synthetic seeds production and testing storability and germination efficiency.
27, 28, 29, 30, 31 ,32	Direct regeneration into whole plants using bud, node and other tissues.

Suggested readings:

1) Plants from Test Tubes: An introduction to Micropropagation (Fourth Edition) – Lydiane Kyte, John Kleyn, Holly Scoggins and Mark Bridgen (Timber Press)
2) Introduction top Plant Tissue Culture- M. K. Razdan (Science Publisher)
3) Somatic Embryogenesis: Fundamental Aspects and Application – Loyola-Vargas, Victor, Ochoa-Aleja, Neftali (Springer)
4) Plant Tissue Culture, Techniques and Experiment – Robert H Smith (AP)
5) Plant Tissue Culture- Protocols in Plant Biotechnology - M.C. Gayatri and R. Kavyashree (Narosa Publishing)
6) Practical biotechnology and Plant Tissue Culture- Prof. Santosh Nagar, Dr. Madhavi Adhav (S Chand)

Course :	*ENTO 243*		***Credit:***	*2(1+1)*	***Semester-IV***
Course title:	*Pest of Horticultural Crops and their Management*				

Syllabus

Theory

General – economic classification of insects. Ecology and insect-pest management with reference to fruit, plantation crops. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, vegetable, ornamental, spices and condiments crops like citrus, mango, grapevine, pomegranate, guava, fig, banana, papaya, custard apple, ber, sapota, aonla, coconut, arecanut, cashew, apple, tea, coffee, brinjal, okra, tomato, chilli, potato, sweet potato, cruciferous, cucurbitaceous, colocassia and moringa, turmeric, ginger, onion, garlic, coriander, curry leaf, black pepper, rose, gerbera and carnation.

Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: Fruit Crops, Vegetable Crops, Plantation, Spices and Condiments.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage %
	Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting-	
1.	**Citrus:-** Lemon butterfly,White fly, Black fly, Leafminer,Fruit sucking moth, (*Eudocimafullonica*C, *E. materna* L.*Achoeajanata*L.), Citrus psylla,Citrus aphids, Mealybug, Citrus thrips,Scale insects	50
2.	**Mango:-**Mango stem borer,Mango stone weevil,Mango fruit fly, Mealy bugs, Mango hoppers, Shoot borer, Thrips,Slug caterpillar, Midge fly, Leaf gall	
3.	**Grapevine:-**Flea beetle /Udadya beetle, Thrips, StemGirdler, Mealy bug, Mite	
4	**Guava:-**Fruit fly, Spiraling white fly, Bark eating caterpillar, Fruit Borers- **(** *Congethes (Dichocrocis) punctiferalis,Deudorix (Virachola) isocrates, Rapalavaruna,)*Green Scale, Mealy bug.	
5	**Banana:-**Root stock weevil/Rhizome weevil, Pseudostem borer, Fruit rust thrips, Aphids, Tingid or Lace wing bug, Leaf eating caterpillar **Papaya:-**Papaya mealy bugs, White fly, Green peach aphid, Ash weevils,	
6	**Sapota :-**Chiku moth / Sapota Leaf Webber, Sapota seed borer, Fruit fly, Stem borer, Hairy caterpillar, Leaf folder, Bud borer.	
7	**Coconut:-**Rhinocerosbeetle, Black headed caterpillar, Red palm weevil, Eriophyid mite, Rat.	
8	**Aracanut:-** Spindle Bug, Inflorescence Caterpillar, **Cashew nut:-**Tea mosquito bug,Cashew stem and root borer, Thrips	
9	**Apple** :-Mites, Codlingmoth, **Fig** :-Jassids, Mites **Ber:-** Ber fruit borer, Ber fruit fly **Aonla**:- Bark Borer,	
10	**Pomogranate:-**Anar caterpillar, Fruitsuckingmoth*(* *Eudocimafullonica, Eudocima materna, Achoeajanata L.*) Thrips, Shot hole borer, Barkeatingcaterpiller, Mealy bug, Whitefly, Aphids,	

Lecture	Topic	Weightage %
11.	**Brinjal:-** Brinjal shoot & fruit borer, Jassids /leaf hopper, Aphids, Whiite fly, Red Spider Mites, Hadda Beetle,Brinjal leaf roller, Lace wing bug, Stem borer **Okra:-**Shoot & fruit borer,Leafhoppers, Aphids, White fly,Leaf Roller, Red Spider Mite**,***Helicoverpa,* Flea beetle,Leaf miner (*Liriomyza)*	40
12	**Tomato** :-Fruit borer,Leaf miner- *Liriomyza* and *Tutaabsoluta* Aphids, Thrips, White Fly,Mites **Chilli:-** Thrips, Fruit borer (*Helicoverpa*), Mites.	
13	**Potato:-** Potato tuber moth, Cutworm, Thrips, Mites, Jassids **Sweet potato**:-Sweet potato weevil, Sweet potato leaf eating caterpillar / Sphinx caterpillar.	
14	**Cruciferous crops (Cauliflower, Cabbage, Broccoli and Knolkol):-** Diamond back moth, Aphids, Painted bug, Cabbage butterfly, Leaf eating caterpillar, Flea beetle,Head borer andMustard saw fly	
15	**Cucurbitaceous vegetables:-** Fruit Fly, Aphids, Leaf miner, whitefly,Thrips, Pumpkinn beetle, Blister beetle **Colocassia and Moringa**:- Leaf eating catterpiller, Webworm, Stem borer, Spodoptera and Aphid,	
16	**Turmeric and Ginger:-**Rhizome fly, Shoot borer, Rhizome scale, Leaf roller, Thrips **Onion and Garlic:-**Onion and garlic thrips**,** **Coriander :-** Mites, Aphids **Curry leaf:-**Scale insect, Psylla, Leamon butterfly **Black pepper:-**Pollu beetle/Floes beetle, Mealy bug,	10
17	**Rose, Gerbera, carnation:-**Thrips, Mites, White Fly, Bud borer, Leaf miner **Ornamental:-** Snail and slugs,Mealy bug, Scale insects,	
18.	**Tea:-** Tea Green leaf Hopper, Tea mosquito bug, Mites **Coffee:-**Coffee seed borer, Coffee berry borer	
	Total	**100**

b) Practical

Experiment	Topic
1	Identification, Damage symptoms and management of - Pests of Citrus
2	Pests of Mango
3	Pests of Grapevine

4	Pests of Guava
5	Pests of Banana and Papaya
6	Pests of Sapota
7	Pests of Coconut
8	Pests of Aracnut and Cashew nut
9	Pests of Pomegranate
10	Pests of Apple, Fig, Ber, Aonla
11	Pests of Brinjal, Okra
12	Pests of Tomato, Chilli
13	Pests of Potato, Sweet potato
14	Pests of cruciferous vegetables
15	Pests of cucurbitaceous vegetables and Colocassia and Moringa
16	Pests of Turmeric, Ginger, Onion, Garlic, Curry leaf, Black Pepper and Coriander
17	Pests of Rose, Gerbera, Carnation, and Ornamentals
18	Pests of Tea and Coffee

Marks for Practical Examination:-Practical Manual :05
Insect collection :05
Spotting :36
Viva :04
Total : 50

Suggested Readings:

1) *A.S. Atwal and G.S. Dhaliwal: Agricultural Pests of South Asia and their Management*
2) *B.V. David and V.V. Rammurthy: Elements of Economic Entomology*
3) *Pedigo L.P.: Entomology and Pest Management.*
4) *VenuGopalRao: Insect Pest Management*
5) *S. Pradhan: Insect pests of crops*
6) *V.B. Awasthi: Introduction of General and Applied Entomology.*

Course :	*HORT 243*		***Credit:***	*2(1+1)*	***Semester-IV***

Course title:	*Production Technology for Fruit and Plantation Crops*

Syllabus

Theory

Importance and scope of fruit and plantation crop industry in India; High density planting; Use of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, apple, pear, peach and; minor fruits-pineapple, pomegranate, jackfruit, strawberry, nut crops; plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation.Scarification and stratification of seeds.Propagation methods for fruit and plantation crops including Micro-propagation.Description and identification of fruit.Preparation of plant bio regulators and their uses, Pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchard.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	Importance and scope of fruit and plantation crop industry in India	05
2	High density planting; Use of rootstocks	05
3	Special Horticulture practices	05
	Production technologies for the cultivation of major fruits	
4	Mango	10
5	Banana	10
6	Citrus	20
7	Grape	
8	Guava	
9	Litchi	
10	Papaya	05
11	Apple, Pear and Peach	05
12	Minor fruits- pineapple & Pomegranate	05
13	Minor fruits- Jackfruit &Strawberry	05
14	Nut crops; plantation crops-Coconut &Arecanut	10
15	Cashew	10
16	Tea, coffee & rubber	05
	Total	**100**

b) Practical

Experiment	Topics
1	Seed propagation
2	Scarification and stratification of seeds
3	Propagation methods for fruit crops including Micro-propagation
4	Propagation methods for plantation crops including Micro-propagation
5	Description and identification of fruit
6	Description and identification of Plantation crops
7	Preparation of plant bio regulators and their uses
8	Establishment of commercial nursery, Nursery Act
9	Establishment of model orchard and its economics
10	Intercropping and multistoried cropping
11	Rejuvenation of old senile orchards
12	Pests of above fruit and plantation crops
13	Diseases of above fruit and plantation crops
14	Physiological disorders of above fruit and plantation crops
15	Visit to commercial orchard of fruits
16	Visit to commercial orchard of plantation crop

Suggested Readings:

Book No.	Title of Book	Authors
1	Handbook of Horticulture	ICAR publication
2	Tropical and Subtropical Fruit crops	T.K.Bose and others
3	Fruit Culture in India	Sham Singh and others
4	Fruits	Ranjit Singh
5	Physiology of Fruit Production	Amar Singh
6	Coconut	Thumpan
7	Advance s in Horticulture	Ed by K.L.Chadha
8	Temperate fruits	Mitra, Thakur and Bose
9	Introduction to spices and Plantation crops	N.Kumar
10	Plantation Crops	J.S.Pruthi

Course :	*ECON 242*		***Credit:***	*3(2+1)*	***Semester-IV***
Course title:	*Agricultural Finance and Cooperation*				

Syllabus

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, Deposit Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development 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, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

Practical

Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprise.

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.

Teaching Schedule

a) Theory

Lecture No.	Topic/Lesson	Weightages
1	Definition of agricultural finance – nature – scope - meaning - significance - micro & macro finance	4
2	Credit needs in agriculture – meaning and definition of credit - classification of credit based on time, purpose, security, lender and borrower	8
3	Credit analysis - Economic feasibility tests- Returns to investment, Repayment capacity and Risk bearing ability (3Rs)	8

Lecture No.	Topic/Lesson	Weightages
4	Five Cs of credit - Character, Capacity, Capital, Condition and Common sense and Seven Ps of credit - Principle of productive purpose, Principle of personality, Principle of productivity, Principle of phased disbursement, Principle of proper utilization, Principle of payment and Principle of protection	6
5	Methods and mechanics of processing loan application.	5
6	Repayment plans: Lump sum repayment /straight-end repayment, Amortized decreasing repayment, Amortized even repayment, Variable or quasi variable repayment plan, Future repayment plan and Optional repayment plan	6
7	Recent trends in agricultural finance - Social control and Nationalization of Banks	5
8	Lead Bank Scheme – origin – objectives - functions and progress; Regional Rural Banks (RRBs) – origin – objectives – functions – progress - RRBs in Andhra Pradesh	8
9	Crop Loan System: objectives – importance - scale of finance – estimation – Term Loans – objectives and interest rates, kisan credit card	8
10	Schemes for financing weaker sections - Differential Interest Rate (DIR), Integrated Rural Development Programme (IRDP), Ganga Kalyan Yozana (GKY), Swarnajayanti Gram Swarozgar Yojana (SGSY), Self Help Groups etc.	8
11	Crop Insurance - meaning and its advantages - progress of crop insurance scheme in India - limitations in application - Agricultural Insurance Company of India – National Agricultural Insurance scheme (NAIS) - salient features - Weather insurance	5
12	Higher Financing Agencies - Reserve Bank of India (RBI) - origin – objectives and functions - role of RBI in agricultural development and finance; National Bank for Agricultural and Rural Development (NABARD) - origin, functions, activities and its role in agricultural development; International Bank for Reconstruction and Development (IBRD); International Monetary Fund (IMF); International Development Agency (IDA); Asian Development Bank (ADB); Deposit Insurance and Credit Guarantee Corporation of India	8
13	Co-operation – meaning - scope, importance and definition - principles - objectives of co-operation	6
14	Origin and history of Indian cooperative movement – cooperative movement during pre-independence period - progress of	4

Lecture No.	Topic/Lesson	Weightages
	cooperative movement during post-independence period	
15	Short comings of Indian co-operative movement and remedies - recommendations of various committees – development of cooperative credit and non-credit organizations- co-operative credit structure	4
16	Classification of co-operative credit institutions - Short Term (ST), Medium Term (MT) and Long Term (LT) Credit – Primary Agricultural Cooperative Credit Societies (PACS) - Farmers Service Societies (FSS) - Multi-Purpose Cooperative Credit Societies (MPCS) and Large-Sized Adivasi Multipurpose Cooperative Societies (LAMPS) - Objectives and functions - Reorganization of Rural Credit Delivery System and concept of single window system – Andhra Pradesh mutually aided Co-operative Societies Act,1995	7

b) Practical

Exercise No	Topics
1	Working out the various repayment plans
2	Study of commercial banks/ RRB
3	Study of NABARD
4	Study of PACS/ DCCB
5	Study of SHGs
6	Estimation of scale of finance
7	Estimation of indemnity
8	Estimation of credit limits under Kisan Credit Card
9	Study of FSS
10	Study of Dairy co-operatives/ any other co-operative institution
11	Appraisal of loan proposal-A case study
12	Techno-Economic parameters for preparation of projects

Exercise No	Topics
13	Preparation of bankable projects for various agricultural products and its value added products
14	Seminar on selected topics
15	Final Practical Examination

Suggested Readings:

1) Ghosal, S.N., Agricultural Financing in India, Asia Publishing House, Bombay, 1966
2) Johl, S.S. and C.V. Moore., Essentials of Farm Financial Management, Today and Tomorrow's Printers and Publishers, New Delhi, 1970
3) John, J. Hamptron., Financial Decision Making: Concepts, Problems and Cases, Prentice-Hall of India , New Delhi, 1983
4) Kenneth, Duft D., Principles of Management in Agribusiness, Reston Publishing Company, Reston, 1979
5) Mamoria, C.B. and R.D. Saksena., Co-operation in India, Kitab Mahal, Allahabad, 1973
6) Mamoria, C.B. and Saksena., Agricultural Problems in India, Kitab Mahal, Allahabad
7) Mukhi, H R. Cooperation in India and Abroad. New Heights Publishers, New Delhi, 1983
8) Muniraj, R., Farm Finance for Development, Oxford & IBH Publishing Company Private Ltd., New Delhi, 1987
9) Subba Reddy, S. and P.Raghuram., Agricultural Finance and Management, Oxford & IBH Publishing Company Private Ltd., New Delhi, 2005
10) Subba Reddy, S., P.Raghuram., P. Sastry, T.V.N. and Bhavani Devi I. Agricultural Economics., Oxford & IBH Publishing Company Private Ltd., New Delhi, 2010
11) William, G. Murray and Nelson Aarson, G., Agricultural Finance, The Iowa State University Press, Ames, Iowa, 1960

Course :	*ELE EXTN 244*		***Credit:***	*3(2+1)*	***Semester-IV***
Course title:	*Agricultural Journalism*				

Syllabus

Theory

- ***Journalism :*** *Meaning, definition, importance*
- ***Agricultural Journalism :*** *Meaning, definition, agricultural journalism in rural areas, problem and prospectus of agricultural journalism*
- ***Agricultural Journalism:*** *The nature and scope of agricultural journalism, characteristics and training of the agricultural journalist, how agricultural journalism is similar to and different from other types of journalism.*

- ***Newspapers and magazines as communication media****: Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers.*
- ***Form and content of newspapers and magazines:*** *Style and language of newspapers and magazines, parts of newspapers and magazines.*
- ***The agricultural story:*** *Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story.*
- ***Gathering agricultural information:*** *Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources.*
- ***Writing the story:*** *Organizing the material, treatment of the story, writing the news lead and the body, readability measures.*
- ***Illustrating agricultural stories:*** *Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions.*
- ***Editorial mechanics:*** *Copy reading, headline and title writing, proofreading, lay outing.*

Practical

1) Practice in interviewing.
2) Covering agricultural events.
3) Abstracting stories from research and scientific materials and from wire services.
4) Writing news story
5) Writing magazine story
6) Writing success story.
7) Preparation of leaflet
8) Preparation of folder
9) Script writing for radio and television
10) Selecting pictures and artwork for the agricultural story.
11) Practice in editing, copy reading, headline and title writing,
12) Use of proofreading symbols
13) Preparing layout of farm publication
14) Preparing cover design of farm publication
15) Testing copy with a readability formula.
16) Visit to press to understand the process of publication of newspaper

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	**Journalism :** Meaning, definition, importance	5
2, 3	**Agricultural Journalism :** Meaning, definition, agricultural journalism in rural areas, problem and prospectus of agricultural journalism	10
4, 5, 6, 7	**Agricultural Journalism:** The nature and scope of agricultural journalism, characteristics and training of the	10

	agricultural journalist, how agricultural journalism is similar to and different from other types of journalism	
8, 9, 10, 11	**Newspapers and magazines as communication media:** Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers	10
12, 13, 14, 15	**Form and content of newspapers and magazines:** Style and language of newspapers and magazines, parts of newspapers and magazines	10
16, 17, 18, 19	**The agricultural story:** Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story	10
20, 21, 22, 23	**Gathering agricultural information:** Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources	10
24, 25, 26, 27	**Writing the story:** Organizing the material, treatment of the story, writing the news lead and the body, readability measures	15
28, 29	**Illustrating agricultural stories:** Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions	10
30, 31, 32	**Editorial mechanics:** Copy reading, headline and title writing, proofreading, lay outing	10
	Total	**100**

b) Practical

Exercise	Topic
1	Practice in interviewing
2	Covering agricultural events
3	Abstracting stories from research and scientific materials and from wire services
4	Writing news story
5	Writing magazine story
6	Writing success story
7	Preparation of leaflet
8	Preparation of folder
9	Script writing for radio and television
10	Selecting pictures and artwork for the agricultural story
11	Practice in editing, copy reading, headline and title writing
12	Use of proofreading symbols
13	Preparing layout of farm publication
14	Preparing cover design of farm publication
15	Testing copy with a readability formula
16	Visit to press to understand the process of publication of newspaper

Suggested Reading

1. Arvind Kumar (1999). The Electronic Media. Anmol Publications, New Delhi.

2. Bhatt, S.C. (1993) Broadcast Journalism. Basic Principles HarAnand Publications, Delhi

3. Bhatnagar, R. (2001). Print Media and Broadcast Journalism. Indian Publisher Distributors, Delhi

4. Katyal, V.P (2007). Fundamentals of Media Ethics. Cyber Tech Publishers, New Delhi.

5. Yadava, J.S and Mathur, P. (1998). Issues in Mass Communication: the basic concepts. Volumes 1 and 2. Indian Institute of Mass Communication, New Delhi.

Course :	*ENGG 243*		***Credit:***	*2(1+1)*	***Semester-IV***
Course title:	*Renewable Energy and Green Technology*				

Syllabus

Theory

Classification of energy sources, contribution of these of sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application, Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and biooil production and their utilization as bioenergy resource, introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application, introduction of wind energy and their application.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, To study gasifier, To study the production process of biodiesel, To study briquetting machine, To study the production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing. To study solar cooker, To study solar drying system. To study solar distillation and solar pond.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	Classification of energy sources	4
2	Energy utilization pattern in crop production	5
3	Biofuels: Introduction, Ethanol production process, Biodiesel production process, Environmental Benefits	8
4	Biogas: Introduction, process description, Constituents of biogas, main features of biogas plant, Classification & Popular designs, Applications	8
5	Gasifier :Types of gasifier, Gasification process, Producer gas and its constituents	8
6	Bio-oil: Pyrolysis or Destructive distillation	5
7	Solar Energy: Introduction Collection and applications	6
8	Solar Energy Devices: Solar Cooker	6
9	Solar Water Heater	6

Lecture	Topic	Weightage (%)
10	Solar Distillation (solar still)	6
11	Solar Dryer	6
12	Solar Pond	6
13	Solar Photo-voltaic System (SPV)	6
14	Wind energy (Introduction, characteristics, measurement equipment, conversion systems, uses of wind energy systems)	7
15	Some other Renewable Energy Sources: Ocean thermal energy conversion, Tidal energy, Geothermal Energy, Hydrogen Energy, Fuel cells, Hydroelectric.	7
16	Use of New and Renewable energy sources in energy conservation	6
	Total	**100**

b) Practical

Experiment	Topic
1.	Study of floating drum biogas plants.
2.	Study of fixed drum biogas plants
3.	Study of different types of gasifiers.
4.	Study of the production process of biodiesel
5.	Study of production process of ethanol.
6.	Study of Solar Photovoltaic fencing.
7.	Study of box type solar cooker.
8.	Study of parabolic cooker.
9.	Study of solar water heater.
10.	Study of solar dryer.
11.	Study of solar water pumping system.
12.	Study of solar lightning system.
13.	Study of solar photovoltaic system.
14.	Study of solar distillation system.
15.	Study of the solar pond.
16.	Visit to Renewable energy integrated plant.

Suggested Readings

1. *Non-conventional Energy Sources by G. D Rai 5th Edition. KhannaPubhishers, Delhi*
2. *Renewable Energy Theory and Practice by N.S. Rathore, N.L. Panwar, A.K. Kurchania. Himanshu Publications, Udaipur.*
3. *Handbook of Agricultural Engineering, ICAR Publication.*
4. *Solar Energy Utilization by G.D. Rai 5th Edition. KhannaPubhishers, Delhi.*

5. *Solar Energy: Principles of Thermal Collection and Storage by S.P. Sukhatme& J.K. Nayak 3rd Edition. McGraw Hill Education, Delhi.*
6. *Principle of Renewable Energy – Twidell and Weir.*
7. *Principle of Energy Conversion. Culp A.W. 1991. McGraw Hill Pub. Co. Inc.*
8. *Dufee J.A. and Beckman W.A. 1986. Renewable Energy Sources. E and FA Spon. Ltd. London*
9. *Biotechnology and Other Alternative Technologies for Utilization of Biomass and Agricultural Wastes by AmlenduChakravarti.*
10. *Biogas Technology; A practical Handbook by K. C. Khandalwal and S.S Mahdi, 1986.*

Course :	*ELE PATH 243*		***Credit:***	*3(2+1)*	***Semester-IV***
Course title:	*Biofertilizers, biocontrol agents and biopesticides*				

Syllabus

Theory

Biofertilizers: Introduction and types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system, History of biofertilizers production Classification of biofertilizers microorganisms used in biofertilizers production. A study of growth characteristics of various microbes used in biofertilizers production. Nitrogen cycle in Nature. Process of nodule formation ,Role of Nif and Nod gene in Biological Nitrogen fixation, Enzyme nitrogenase and its component, Biochemistry of nitrogen fixation, Cross inoculation groups amongst *Rhizobium*, Methods used for the studying selection of efficient strain of *Rhizobium* .Quality standard for biofertilizers different methods of application of biofertilizers, role of microorganisms in decomposition of organic farm wastes, methods of quality control assessment in respect of biofertilizers, Strategies of Mass multiplication and packing Registration of biofertilizers. Strategies of marking and Registration with CIB of bioagents and biopesticides

Importance of *Trichoderma* spp., *Pseudomona*s spp. and *Bacillus* spp. as a biocontrol agents,Mechanism of disease control by thses organisms bioagents .Types of diseases controlled bioagents formulations, Effectiveness of bioagents against seed borne and soil borne plant pathogens, Mass multiplication and packing , Strategies of marking, and Registration with CIB and organic farming institute

Importance of *Trichogramma, Cryptolaemus, Chrysoperla,* NPV and entomofungal pathogens. Establishing insectary for host insects and natural enemies, Mass production of *Verticillium/Beauveria/Metarhzium/Nomuraea/Paecilomyces*/*Hirsutella thompsoni/Trichoderma,/Pseudomonas/Bacillus/Potash Mobilizers/Sulphur oxidizers /organic matter decomposers*

Practical

Equipment, machinery and tools used for biofertilizers,Biopesticides and bioagents production. Preparation of media used for isolation and culturing of biofertilizers : Jensen's agar, NFb medium, Yeast extract manitol agar, BGA-medium, Pikovaskaya's medium ; Isolation of *Rhizobium* from root nodulesIsolation *Azotobacter* from rhizosphere of cereal crops, *Beijernickia, Acetobacter*from soil, *Azospirillium* from roots of graminicious plants, BGA from soil, Mycorrhizae from the roots,PSM sulphur oxidizing microorganisms, ion chealator, potash mobilizers ,organic matter decomposers and their isolation in pure culture form. Estimating the efficiency of *Rhizobium* through pot culture experiments and through nodulation tests in test tubes and Leonard jar.. Preservation of cultures of these organisms. Production of commercial biofertilizers *viz*. *Rhizobium, Azotobacter, Azospirillum* and *Acetobacter* : selection of efficient strains, carriers and their sterilization, mother culture preparation, mass multiplication using shake culture method, mixing of culture and carriers and preparation of packets. Production of carrier based and grain based phosphate solubilizing biofertilizers.

Methods of mass multiplication of BGA and *Azolla*.A large scale production of decomposting cultures. Va-mycorrhiza : growth on Guinea grass roots and observations for root colonization. Preparation of VA-mycorrhizal inoculum.

Methods of application of*Rhizobium, Azotobacter*, *Azospirillum* and phosphate solubilizing biofertilizers. Methods of application of *Azolla* and blue green algal biofertilizers in paddy farming.Production of compost cultures.

Quality control of biofertilizers : ISI standards specified and estimating the viable bacterial count in carrier based biofertilizers. Storage of biofertilizer packets. Visit to biofertilizer plants. Preparation of plan of biofertilizer production unit and proposal of loan.

Biopesticide and bioagents :Mass production of *Trichogramma, Cryptolaemus, Crysoperla,*Mass HaNPV, and EPN. Importance of*Verticillium/Beauveria/ Metarhzium/Nomuraea/ Paecilomyces*/*Hirsutella thompsoni/Trichoderma,/Pseudomonas/Bacillus/ organic matter decomposers.* Testing of quality parameters and standardization of biopesticides.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	Introduction and types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system	3
2	History of biofertilizers production	5
3,4	Classification of biofertilizers microorganisms used in biofertilizers production	4
5	A study of growth characteristics of various microbes used in biofertilizers production	4
6	Nitrogen cycle in Nature and its importance	5
7	Process of nodule formation ,Role of Nif and Nod gene in Biological Nitrogen fixation	3

Lecture	Topic	Weightage (%)
8	Enzyme nitrogenase and its component	3
9	Biochemistry of nitrogen fixation,	4
10	Cross inoculation groups amongst *Rhizobium*,	3
11	Methods used for the studying selection of efficient strain of *Rhizobium*	5
12	Quality standard for biofertilizers, ,.	3
13	Different methods of application of biofertilizers, biopesticides and bioagents	5
14	Methods of quality control assessment in respect of biofertilizers	3
15	Strategies of Mass multiplication and packing Registration of biofertilizers	4
16,17	Strategies of marking and Registration with CIB of bioagents and biopesticides	4
18	Role of microorganisms in decomposition of organic farm wastes	4
19,20	Importance of *Trichoderma* spp., *Pseudomona*s spp. and *Bacillus* spp. as a biocontrol agent.	4
21	Mechanism of disease control by these organisms bioagents	3
	Types of diseases by controlled bioagents formulations	3
22	Factors responsible for effectiveness of bioagents against seed borne and soil borne plant pathogens	4
23	Mass multiplication and packing	2
24,25	Strategies of marking, and Registration with CIB and organic farming institute	4
26,27	Importance of *Trichogramma, Cryptolaemus, Chrysoperla,* NPV and entomofungal pathogens.	4
28	Establishing insectary for host insects and natural enemies	3
29	Mass production of bioagents *Trichoderma,Bacillus,*Pseudomonas	4
30	Quality parameters as per CIB specifications, Registration of biopesticides and case	3
31,32	Importance of *Verticillium/Beauveria/ Metarhzium/Nomuraea/ Paecilomyces*/*Hirsutella thompsoni* as biopesticides and their mass production	4
	Total	**100**

b) Practical

Experiment	Topic
1	Equipment, machinery and tools used for biofertilizers, Biopesticides and bioagents production.
2	Media used for biofertilizers, Biopesticides and bioagents production.
3	Isolation of *Rhizobium* from root nodules. Isolation of *Azotobacter ,Acetobactor,Beijernickia,Azospirillium*. I. By dilution pour plate technique and II. By enrichment culture technique
4	Isolation of *BGA,PSB*, sulphur oxidizing microorganisms, ion chealator, potash mobilizers ,organic matter decomposers I. By dilution pour plate technique and II. By enrichment culture technique
5	Estimating the efficiency of *Rhizobium* through pot culture experiments and through nodulation tests in test tubes and Leonard jar.

Experiment	Topic
6	Production of *Rhizobium* commercial biofertilizers of *Azotobacter* , *AzospirillumAcetobacter,* organic matter decomposers
7	Production of carrier biofertilizers of sulphur oxidizing microorganisms, ion chealator, potash mobilizers
6	Study of VA-mycorrhiza: growth on Guinea grass roots and observations for root colonization. Methods of preparation and application of VA-mycorrhizal inoculum
7	Mass production of Trichogramma,Cryptolaemus,Crysoperla
8	Mass production of HaNPV, SlNPV and EPN
9	Mass production of *Verticillium/Beauveria/ Metarhzium/Nomuraea/ Paecilomyces/Hirsutella thompsoni/Trichoderma*
10	Mass multiplication of BGA and *Azolla* and its application in paddy field
11	Methods of application of biofertilizers, Biopesticides and bioagents
12	Quality control of biofertilizers: ISI standards specified and estimating the viable bacterial count in carrier based biofertilizers, Biopesticides and bioagents
13	Quality control tests for the biofertilizers, Biopesticides and bioagents
14	Preparation of plan of biofertilizers, Biopesticides and bioagents production unit and proposal of loan.
15	CIB Registration for Biopesticides and bioagents
16	Visits to Commercial biocontrol units and Krishi Seva Kendra.

Suggested Readings

1. Alexander M. 1977. Soil Microbiology. John Wiley.
2. Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
3. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.
4. Subba Rao, N.S. Biofertilizers in Agriculture and Forestry. 1993. Oxford and IBH. Publ. Co., New Delhi.
5. Burges, H.D. and Hussey, N.W. (1971). Microbial Control of Insects and mites. Academic Press, New York.
6. Burges, H.D. Formulation of microbial pesticides – Kluversep, ACB, Dordrecht-ISBN. 0412 625 202.
7. Coppel H.C. and J.W. Martin. (1977). Biological control of insect pest suppression. Springail.
8. De Bach P. 1964. Biological control of Insect Pest and Weeds Chapman and Hall, New York.
9. Gautam, R.D. (2006). Biological suppression of insect pests. Kalyani Publisher, New Delhi.
10. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
11. Ignacimuthu, S.S. and Jayaraj, S. (2003). Biological Control of Insect Pests. Phoenix Publ. New Delhi.
12. Saxena, A.B. (2003). Biological Control of Insect Pests. Anmol Publ. New Delhi.

13. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
14. Pepper HJ and Perlman D. 1979. Microbial Technology. 2nd Ed. Academic Press.
15. A century of Nitrogen Fixation Research Present status and Future propects. 1987. F.J. Bergersen and J.R. Postgate The Royal Soc., London.
16. Biology and Biochemistry of Nitrogen fixation. 1991. M.J. Dilworth,and A.R. Glenn, Elsevier, Amsterdam. .
17. Nitrogen Fixation in plants. 1986. R.O.D. Dixon,and C.T. Wheeler, Blackie USA, Chapman and Hall, New York.
18. A treatise on dinitrogen Fixation Section IV. Agronomy and Ecology 1977. R.W.F Hardy, and A.H. Gibson John Wiley & Sons, New York..
19. Bioresearches technology for sustainable agriculture. 1999. S. Kannaiyan, Assoc. Pub. Co., New Delhi.
20. Biofertilizer Technology, Marketing and usage- A source Book -cum-glossary 1995. Motsara, I. M.R., P. Bhattacharyya and Beena Srivastava, FDCO, New Delhi.
21. Symbiotic nitrogen fixation in plants, 1976. P.S. Nutman, Cambridge Univ. Press, London.
22. Hand book for Rhizobia; Methods in legume Rhizobium Technology, 1994. P. Somasegaran and H.J. Hoben Springer-Verlag, New York.
23. Biofertilizers in Agriculture and Forestry 1993. N.S. Subba Rao Oxford and IBH Publ. Co., New Delhi.

Course :	*SSAC 242*		***Credit:***	*2(1+1)*	***Semester-IV***
Course title:	*Problematic Soils and their Management*				

Syllabus

Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Theircategorization based on properties. Reclamation and management of Saline and sodic soils, Acidsoils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils.Irrigation water – quality and standards, utilization of saline water in agriculture. Remotesensing and GIS in diagnosis and management of problem soils.Multipurpose tree species, bio remediation through MPTs of soils, land capability andclassification, land suitability classification. Problematic soils under different Agro-ecosystems.

Practical

Saturation paste extract, its analysis for pHe and ECe, soluble cations and anions, competition of SAR and RSC. Exchangeable sodium percentages of soil, gypsum requirement of sodic soil, lime requirement of acidic soils. Irrigation water sampling technique, sewage water.Determination of pH, EC, soluble cations and anions. Computation

of RSC and SAR, BOD and COD of sewage water, Satellite image analysis of salt affected soils

Teaching schedule

a) Theory

Lecture	Topic	Weightage (%)
1-2	Soil degradation: Concept, types, factors and processes. Soil quality and soil health: definition and concept, soil quality indicators. Characteristics of healthy soils.	6
3-4	Distribution and extent of waste land and problematic soils in India and Maharashtra. Categorization of problem soils based on properties.	6
5-6	Saline soils, alkali Soils, saline-alkali soils, degraded alkali soils, coastal saline soils: definition, formation, characteristics, effect on plant growth, reclamation and management. Acid and acid sulphate soils: definition, formation, characteristics, effect on plant growth, reclamation and management.	12
7-8	Calcareous Soil: definition, formation, characteristics, effect on plant growth, reclamation and management.	8
9	Eroded soils and compacted soils: definition, formation, characteristics, effect on plant growth, reclamation and management.	6
10	Submerged soils and flooded soils: definition, formation, characteristics, effect on plant growth, reclamation and management.	10
11	Polluted soils: definition, sources and their remediation.	10
12	Water pollution: definition, sources and their remediation.	6
13	Quality of Irrigation water and its suitability for irrigation.	6
14	Utilization of saline and sewage water in Agriculture.	6
15	Remote sensing and GIS in diagnosis and management of problem soils.	6
16	Multipurpose tree species and bioremediation of soils.	6
17	Land capability classification and Land suitability classification.	6
18	Problematic soils under different Agro-ecosystem.	6
	Total	**100**

b) Practical

Experiment	Topic
1 & 2	Preparation of saturation paste extract.
3	Determination of pH_e and EC_e .
4 & 5	Determination of cations (Ca, Mg, Na and K) and computation of SAR.
6 & 7	Determination of ESP of soils.

8	Determination of gypsum requirement of sodic soil.
9	Determination of calcium carbonate from soil.
10	Determination of lime requirement of acidic soil.
11	Collection of irrigation water and sewage water.
12	Determination pH and EC from irrigation water.
13 & 14	Determination of cations (Ca, Mg, Na and K) from irrigation water.
15 & 16	Determination of anions (CO_3, HCO_3, Cl and SO_4) from irrigation water and RSC and SAR.
17	Determination of BOD and COD.
18	Satellite image analysis by visual method .

Suggested Reading

1) *RichardsL. A.. 1954. Diagnosis and Improvement of Saline and Alkali Soils. United State Department of Agriculture.*

2) *Maliwal, G. La. and SomaniL.L. 2010. Nature Properties and Management of Sine and Alkali Soils. Agrotech Publishing Academy, Udaipur 313 002. pp. 335.*

3) *Mahendran , et al. Soil Resource Inventory and Management of Problamatic [i.e. Problematic] Soils. Published by Agrotech Publishing Academy (2012) ISBN 10: 818321097X / ISBN 13: 9788183210973*

4) Abrol, I. P., Yadav, J. S. P and Massoud, F. I. 1988. Salt-Affected Soils and their Management. FAO SOILS BULLETIN 39. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, 1988.

5) *Tyagi, N.K. and P.S. Minhas. 1998. Agricultural Salinity Management in India Published by CSRI.,Kernal. (Price Rs. 500/-).*

6) Yaduvanshi, N. P. S. 2008. Chemical Changes and Nutrient Transformation in Sodic/ Poor Quality water Irrigated Soils . Published by CSRI.,Kernal.

7) Dey, P. , Gupta, S. K. 2012. Diagnostics, Remediation and Management of Poor Quality Waters: Lectures for Summer School by R. L. Meena, S. K. Gupta, R. K. Yadav and D. K. Sharma, 2011. Salinity Management for Sustainable Agriculture in Canal Commands. Published by CSRI.,Kernal.

8) Twenty five years of research on management of salt affected soils & use of saline water in agriculture, 1998 (Price Rs. 75/-). Published by CSRI.,Kernal.

9) *Patil, V. D. and Mali C. V. 2007. Fundamentals of Soil Science, Aman Publication, Meerut.*

10) Das, D. K. Introductory Soil Science

11) Brady, N. C. 2016. The Nature and Properties of Soils. 15th edition Publisher: Pearson Education, ISBN: 978-0133254488.

12) *The chemistry of Soil – Firman Bear*

13) *Text Book of Pedology Concepts and Applications – J. Sehgal*

14) *FAO United Nationss Soils Portal- FAO*

Course :	*AHDS 242*		***Credit:***	*2(1+1)*	***Semester-IV***
Course title:	*Livestock breeding and Nutrition.*				

Syllabus

Theory

History and concept of animal breeding.Cell and cell division, spermatogenesis and oogenesis. Gene: Functions and role in animal genetics, gene actions, gene and genotypic frequencies, gene expression and mutation. Mendelian principles and Hardy Weinberg law.Chromosomes and its abnormalities.Laws of probabilities and animal breeding.Variations in economic traits of farm animals.Systems of breeding.Methods of selection and basis for selection.Quantitative and qualitative traits.Composition of plant and animal body.Classification of feeds and fodders.Important food ingredients and their functions in animal body.Digestive system, digestion and absorption of different nutrients in ruminants. Feed supplements and feed additives. Methods of measuring food values.Feeding standard & their principles.Concept in feed processing eg. Complete feed block, enrichment of low quality roughages and use of unconventional feed stuff. Recent trends in animal feed technology.

Practical

Study of animal cell structure.Estimation of gene and genotypic frequency.Estimation of heritability and repeatability.Estimation of genetic and phenotypic correlation by analysis of variance, co- variance.Estimation of most probable producing ability and breeding value of cow.Study of sire index.Estimation of regression coefficient.Estimation of genetic gain. Estimation of heterosis. Identification of feeds and fodders.Study of desirable characteristics of ration.Evaluation of nutritive value of various feeds and fodders. Study of nutritive values DCP,TDN,NR,SE and GE. Nutrient requirement of different classes of animals. Principles of thumb rule. Computation of ration for different classes of livestock.Conservation of fodder viz. Silage making, Hay making, Chaffing of fodders.Studies on processing of low quality roughages.Study of azolla and hydroponics fodder production.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	History and concept of animal breeding	5
2	Cell and cell division, spermatogenesis and oogenesis	5
3	Gene: Functions and role in animal genetics gene actions, gene and genotypic frequencies	6
4	Gene expression and mutation and laws of probabilities	6
5	Mendelian principles and Hardy Weinberg law	8

Lecture	Topic	Weightage (%)
6	Chromosomes and its abnormalities	8
7	Variations in quantitative and qualitative traits of farm animals	5
8	Systems of breeding	6
9	Methods of selection and basis for selection	6
10	Composition of plant and animal body	6
11	Classification of feeds and fodders	6
12	Important nutrients and their functions in animals body	6
13	Digestive system and digestion of different nutrients in ruminants	6
14	Feed supplements and feed additives, method of measuring food values	7
15	Feeding standards and bypass nutrient technology	8
16	Concept in feed processing eg. Complete feed block, enrichment of low quality roughages and use of unconventional feed stuff	6
	Total	**100**

b) Practical

1. A) Study of animal cell structure
   B) Estimation of gene and genotypic frequency
2. A) Estimation of heritability and repeatability
   B) Estimation of genetic and phenotypic correlation by analysis of variance, co-variance
3. Estimation of most probable producing ability and breeding value of cow
4. Study of sire index
5. Estimation of regression coefficient
6. A) Estimation of genetic gain
   B) Estimation of heterosis
7. Identification of feeds and fodders
8. Study of desirable characteristics of ration
9. Evaluation of nutritive value of various feeds and fodders
10. Study of nutritive values DCP,TDN,NR,SE and GE
11. Principles of thumb rule and nutrient requirement of different classes of animals
12. Computation of ration for different classes of livestock
13. Conservation of fodder A) Silage making, B) Hay making, C) Chaffing of fodders
14. Studies on processing of low quality roughages
15. Study of azolla and hydroponics fodder production
16. Visit to forage farms/ laboratory/veterinary dispensary

Suggested Readings

1) *Lasley, J. S. (1978) Genetics of livestock improvement, New Delhi, Prentice House of India*
2) *Kanakraj, P (2001) A text book of Animal Genetics I, International Book Distributing Co. Lucknow, India*
3) *Jagdish Prasad (1996) Animal Genetics and Breeding practices, International Book Distribution Co. Lucknow, India*
4) *Rice, V. A. & Andrews F. N. (1964) Breeding and Improvement of Farm Animals 6thedBanergee, G. C.(1998)*
5) *Feeds & Principles of Animal Nutrition Oxford and IBH Publ. New Delhi.*
6) *Ranjan, S. K. (1983) Animal Nutrition and Feeding Practices, Kalyani Publ. Ludhiana, New Delhi*
7) *Maynord L. A. Loosli J. K., Hintz H. F. and Warner R. C. (1979) Animal Nutrition 7th ed. Tata Mc Grow – Hill publishing Co. New Delhi*
8) *Reddy, B. V. (2001) Principles of Animal Nutrition and Feed technology oxford and IBH Publ. New Delhi*
9) *Mukherje, D. P. and Banerjee G. C. Genetics and breeding of farm animals. Oxford IBH Publ. Co. Colkota*