UG Ordinance and Syllabi as per 6th Deans Committee Recommendation of ICAR (w.e.f. 2024-25)

Palli Siksha Bhavana
(Institute of Agriculture)
Visva-Bharati, Sriniketan
2024

Brief History of the UG Programme

In tune with the thoughts of Nobel Laureate Rabindranath Tagore, Sriniketan Experiment was started in 1921 concerning with four important areas *viz.* agriculture, crafts and rural industries, village welfare and education. Agriculture was at the core area of Sriniketan Experiment with association of Leonard Elmhirst, Rathindranath Tagore, Santosh Chandra Mazumdar and Nagendranath Ganguly. The Department of Agriculture and Village Economics was formally inaugurated on February 6, 1922 with Mr. L. K. Elmhirst as the first Director. Gurudeva Rabindranath Tagore confided to Mr. Elmhirst on March 1, 1922 that he wanted two things most - a good art department and a good agricultural school. In a unique way Tagore combined his desire to the collective good of mankind with the fullest development of the qualities of the individual. An all-round regeneration of the people, so that the choked bed of village life may again be flooded with stream of happiness was his ideal of rural reconstruction. He believed in missionary zeal and self-sacrifice. But at the same time be warned that the results of service should make people stand on their own legs. The best way of serving them is to help them to help themselves.

Visva-Bharati was declared a Central University and an Institution of National Importance by an Act of Parliament in 1951. In 1957, in accordance with the recommendation of the National Commission on Agriculture of which Mr. Elmhirst was a member, an Institute of Rural Higher Education (popularly known as Rural Institute) as one of few started all over India, was set up at the present site of the Institute of Agriculture. The Institute of Rural Higher Education offered 3-year Diploma Course in Rural Services and 2-year Certificate Course in Agriculture. This Institute was meant to produce Rural Leaders. *Palli Siksha Sadana* took birth in 1963 in place of Rural Institute with two wings - one was College of Agriculture offering 4-years Degree Course in Agriculture and the other was Department of Social Science offering 3-year Degree Course in Social Science. After the passage of time Department of Social Science was renamed as Department of Social Work and shifted to *Palli Samgathana Vibhaga* in 1975. *Palli Siksha Sadana* was renamed as *Palli Siksha Bhavana* (Institute of Agriculture) in 1984 with amendments of Visva-Bharati Act. *Palli Siksha Bhavana* (Institute of Agriculture) is engaged in teaching, research and extension in the field of Agriculture and following the course structure framed by the Indian Council of Agricultural Research (ICAR). The Agricultural Extension programme received impetus with the establishment of Rathindra Krishi Vigyan Kendra (Farm Science Centre) in 1994 to cater the training needs of farmers, farm women and rural youths of the Birbhum district, West Bengal.

Initially four composite departments of *Palli Siksha Bhavana* (Institute of Agriculture) were established in 1989. After the passage of time, these four composite departments were reorganised and nine new Departments had started functioning on and from 1 October 2016 due to an administrative notification of Visva-Bharati dated 30 September 2016. *Palli Siksha Bhavana* (Institute of Agriculture) has always been striving to make higher agricultural education relevant to present day needs, produce graduates, post-graduates with excellence in academics and research skills, entrepreneurial skills for self-employment and contributors of rural livelihood and food security need. Teaching, research and extension efforts give emphasis on building competence and confidence of the human resources in Agriculture. The institute is engaged in teaching offering 4-year undergraduate course in Agriculture since 1963.

PALLI SIKSHA BHAVANA, VISVA-BHARATI

UG ORDINANCE (w.e.f. 2024-25)
(With minor revisions dated 15.07.2025)

B. Sc. (Honours) Agriculture/ UG-Diploma Course in Agriculture/UG-Certificate in Agriculture

1. There shall be a course of studies in Agriculture at Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati on the following National Higher Education Qualification Framework (NHEQF) levels the duration of which shall be as follows:
   - UG-Certificate Course in Agriculture (NEP-NHEQF Level 4.5)-1year
   - UG-Diploma Course in Agriculture (NEP-NHEQF Level 5.0)-2 years
   - B.Sc. (Honours) Agriculture (NEP-NHEQF Level 6.0) - 4 years

2. The system, called the "Course credit and semester", accommodates the under-graduate (UG) course having eight semesters in four years. Usually, the semester I, semester III, semester V and semester VII shall run in the first half of an academic year and semester II, semester IV, semester VI and semester VIII shall run in the second half of the same academic year.

3. The programme for the UG Agriculture Education will be with multiple entry and exit options. at different levels. The student/s will have the option to exit after the 1st year. He/she/ze has to complete 10 weeks of internship (10 credits) after 1st year (2 semesters) to be eligible for award of UG-Certificate.
   The student/s has another option to exit after the 2nd year. The student has to complete another 10 weeks of internship (10 credits) after 2nd year (4 semesters) to be eligible for award of UG-Diploma. The details are presented below:

Year	Types of course	Exit option
Year-1 NHEQF Level 4.5	Foundation courses, introductory courses and skills enhancement training/training in the chosen area, ability enhancement courses	A student/s must complete 10 weeks of internship (10 credits) after 1st year if exit with UG-Certificate in Agriculture is opted
Year-2 NHEQF Level 5	Basic core courses and additional skill enhancement in chosen areas/courses	A student/s must complete 10 weeks of internship (10 credits) after 2nd year if exit with UG-Diploma in Agriculture is opted
Year-3	Advanced core subjects and their practical applications	No exit on and after 3rd years
Year-4 NHEQF Level 6	Specialization/Elective courses and advanced skill enhancement through project and internship	B.Sc. (Honours) Agriculture

4. No exit on and after 3rd years (6 semesters) will be allowed considering the professional nature of the courses. After four years of study (8 semester), the student will be awarded UG degree B.Sc. (Honours) Agriculture.

5. The lateral entry at semester III will be for the candidates having UG-certificate in Agriculture or those who have completed Diploma (3 years course after 10th) in recognised HAEIs. The lateral entry in semester V will be for candidates who have completed UG-Diploma in Agriculture.

6. As per NEP-2020 guidelines, Palli Siksha Bhavana, Visva-Bharati will create an Academic Bank of Credits (ABC) for each student and will recognise the ABC of a student as per the norms of the Visva-Bharati/NEP-2020 recommendations.

7. Palli Siksha Bhavana, Visva-Bharati will adopt the inter-institutional transfer of students with accumulation of the ABC and may admit students either by holding its own admission test or use merit as criteria or by following any of the existing norms of Visva-Bharati in case of both transferring and accepting Universities/HAEIs. The migration shall be subject to availability of seats at the accepting HAEI.

8. Palli Siksha Bhavana will make institutional migration after 4th semester and will have liberty to put in place rules/regulations for relaxing/modifying existing provisions of migration, providing more freedom and ease to students.

9. Students who exit with a UG- Certificate in Agriculture or UG- Diploma in Agriculture are permitted to re-enter within three academic years and complete the degree programme in Agriculture.

10. Students may be permitted to take a break from the study during the period of study but the total duration for completing the programme shall not exceed 7 years.

11. The eligibility for entry into the UG programme in agriculture will be +2 in science stream with a combination of any of the subject combinations i.e., Physics, Chemistry, Biology (PCB)/ Physics, Chemistry, Mathematics (PCM)/ Physics, Chemistry, Biology and Mathematics (PCBM). However, for ICAR nominated candidates, the eligibility criteria adopted by ICAR will be followed as such.

12. Candidates admitted to the B. Sc. (Honours) Agriculture course shall abide by the regulations regarding the course curricula and the academic standards as prescribed by the University/ICAR from time to time.

13. A total of 170-174 credit hours will be required for the four years of UG programme in Agriculture.

14. A bouquet of Elective courses will be offered to the students under B.Sc. (Hons) Agriculture Degree programme at semester VII. The student/s will have the freedom to choose a subject among these courses. The student/s will have to submit an application to the Principal, Palli Siksha Bhavana about their choice, in writing, for different Elective courses among the offered courses before the commencement of the semester. Students should opt five choice-based elective courses (major or minor).

15. Students for the UG programme shall have to pass all the fixed and choice-based courses of studies.

16. There will be a 10-point grading system of evaluation with grade point (GP) equal to percentage of marks obtained divided by 10.

17. There will be two types of courses- “credit course” and “Non-gradial (NG) course”. Grade point obtained only in credit courses will be considered for the classification of results but marks/grade obtained in non- gradial courses will not be considered for classification of results. Further, in credit courses there will be four types of courses- “Only theory course”, “Only practical course”, “Composite course”, “Student READY course”. The composite course will consist of both theory and practical components.

Semester wise course and credits allocation

Course Code	Name of the Course	Course Structure (Credits)		
		Theory	Practical	Total
1st Year – I Semester				
Induction cum Foundation course				
IFC-111	Deeksharambh	2 weeks- Non-gradial (NG)		
Core Courses (Majors and Minors)				
AEX-111	Rural Sociology and Educational Psychology	2	0	2
AGR-111	Fundamentals of Agronomy	2	1	3
SSC-111	Fundamentals of Soil Science	2	1	3
HOR-111	Fundamentals of Horticulture	2	1	3
Multi-Disciplinary Course (MDC)				
MDC -111	Farming based livelihood systems	2	1	3
Value Added Course (VAC)				
CVAC (TS)	Tagore Studies	3	0	3
Ability Enhancement Course (AEC)				
AEC-111	Communication Skills	1	1	2
AEC-112	NSS	0	1	1
Skill Enhancement Courses (SEC)				
Skill Enhancement course-I (Any one)				
SEC-1101	Agro-techniques of Field Crop Production-1	0	2	2
SEC-1102	Mastering NSSO and Survey Analysis	0	2	2
SEC-1103	Commercial Horticulture	0	2	2
Skill Enhancement course-II (Any one)				
SEC-1104	Repair and maintenance of Farm Machinery	0	2	2
SEC-1105	Horticulture Nursery Management	0	2	2
SEC-1106	Soil, Plant and Water Testing	0	2	2
Credit Hours		14	10	24+2 (NG)
Remedial Course				
RC-111	Introductory mathematics (need based) - NG	1	0	1

Course Code	Name of the Course	Course Structure (Credits)		
		Theory	Practical	Total
Multidisciplinary course (other than Agriculture student)				
MD AGR-01	Fundamentals of Agronomy-I	2	1	3
1st Year – II Semester				
Core Courses (Majors and Minors)				
SSC-121	Soil Fertility Management	2	1	3
AEN-121	Fundamentals of Entomology	2	1	3
ANS-121	Livestock and Poultry Management	1	1	2
PPC-121	Fundamentals of Plant Pathology	2	1	3
Value Added Course (VAC)				
VAC-121	Environmental Studies and Disaster Management	2	1	3
Ability Enhancement Course (AEC)				
AEC-121	Personality Development	1	1	2
AEC-122	NSS	0	1	1
Skill Enhancement Courses (SEC)				
Skill Enhancement course-III				
SEC-1201	Agro-techniques of Field Crop Production-II	0	2	2
SEC-1202	Unlocking Agri-data and Forecasting	0	2	2
SEC-1203	Post Harvest Processing Technology	0	2	2
Skill Enhancement course-IV				
SEC-1204	Biofertilizer and Biopesticide production	0	2	2
SEC-1205	Organic Production Technology	0	2	2
SEC-1206	Surveying and Levelling	0	2	2
SEC-1207	Plantation Crops Production and Processing	0	2	2
Credit Hours		10	11	21
Multidisciplinary course (other than Agriculture student)				
MD AGR-02	Fundamentals of Agronomy-II	2	1	3
2nd Year – III Semester				
Core Courses (Majors and Minors)				
AGR-211	Crop Production Technology-I (*Kharif* crops)	1	2	3
AGR-212	Principles and Practices of Natural Farming	1	1	2
AEX-211	Fundamentals of Extension Education	1	1	2
HOR-211	Production Technology of Fruit and Plantation Crops	1	1	2
GPB-211	Principles of Genetics	2	1	3
PPC-211	Fundamentals of Nematology	1	1	2
Multi-Disciplinary Course (MDC)				
MDC-211	Entrepreneurship Development and Business Management	2	1	3
Ability Enhancement Course (AEC)				
AEC-211	Physical Education, First Aid, Yoga Practices and Meditation	0	2	2
Skill Enhancement Courses (SEC)				
Skill Enhancement course-V				
SEC-2101	Production Techniques of Organic Farm Inputs	0	2	2
SEC-2102	Agripreneurship in Agri-Business	0	2	2
SEC-2103	Agriculture Waste Management	0	2	2
SEC-2104	Post-Harvest Engineering	0	2	2
SEC-2105	Beneficial Insect Farming	0	2	2
SEC-2106	Participatory Rural Appraisal	0	2	2
SEC-2107	Poultry Production Technology	0	2	2
SEC-2108	Floriculture and Landscaping	0	2	2
SEC-2109	Formulation of Biopesticides and Botanicals	0	2	2
Credit Hours		9	12	21
Multidisciplinary course (other than Agriculture student)				
MDNF 03	Natural Farming	2	1	3
2nd Year – IV Semester				
Core Courses (Majors and Minors)				
AGR-221	Crop Production Technology-II (*Rabi* Crops)	1	2	3
AGR-222	Water Management	1	1	2

Course Code	Name of the Course	Course Structure (Credits)		
		Theory	Practical	Total
AECO-221	Principles of Agricultural Economics and Farm Management	2	0	2
AEG-221	Farm Machinery and Power	1	1	2
GPB-221	Basics of Plant Breeding	2	1	3
HOR-221	Production Technology of Vegetables and Spices	1	1	2
SSC-221	Problematic Soils and their management	1	1	2
Value Added Course (VAC)				
VAC-221	Agricultural Informatics and Artificial Intelligence	2	1	3
Skill Enhancement Courses (SEC)				
Skill Enhancement course-VI				
SEC-2201	Organic Production Technology of Medicinal and Aromatic Plants	0	2	2
SEC-2202	Food Processing	0	2	2
SEC-2203	Commercial Sericulture	0	2	2
SEC-2204	Video Production	0	2	2
SEC-2205	Piggery Production Technology	0	2	2
SEC-2206	Goat Production and Management	0	2	2
SEC-2207	Seed Production and Testing Technology	0	2	2
SEC-2208	DUS Testing Technology	0	2	2
SEC-2209	Mushroom Production Technology	0	2	2
Credit Hours		11	10	21
3rd Year – V Semester				
Core Courses (Majors and Minors)				
AGR-311	Introduction to Agro-meteorology	1	1	2
AGR-312	Weed Management	1	1	2
AGR-313	Introductory Agro forestry	1	1	2
AST-311	Basic and Applied Agril Statistics	2	1	3
CPH-311	Fundamentals of Crop Physiology	2	1	3
GPB-311	Crop Improvement (*kharif* crops) – I	1	1	2
HOR-311	Ornamental Crops, MAPs and Landscaping	1	1	2
PPC-311	Diseases of Field & Horticultural Crops & their Management	2	1	3
Multi-Disciplinary Course (MDC)				
MDC-311	Agricultural Marketing and Trade	2	1	3
Non-gradial				
ST-311	Study Tour	0	2	2 (NG)
Credit Hours		13	11	22+2 (NG)
3rd Year – VI Semester				
Core Courses (Majors and Minors)				
AGR-321	Dryland agriculture/Rainfed agriculture and watershed	1	1	2
AECO-321	Agricultural Finance & Cooperation	1	1	2
AEG-321	Renewable energy in Agriculture and Allied Sector	1	1	2
AEN-321	Pest management in Crops and Stored Grains	2	1	3
CPH-321	Fundamentals of Seed Science & Technology	1	1	2
GPB-321	Fundamentals of Agri Biotechnology	2	1	3
GPB-322	Crop Improvement (*Rabi* crops) – II	1	1	2
PPC-321	Agricultural Microbiology and Phyto -remediation	1	1	2
ACB-321	Essentials of Plant Biochemistry	2	1	3
Credit Hours		12	9	21
4th Year – VII Semester				
Elective Courses				
Five Elective Courses (major or minor) for B.Sc. (Hons) Agriculture degree		15	5	20
Course Code	**Name of the Course**	**Course Structure (Credits)**		
		Theory	**Practical**	**Total**
EC-4101	Principles and Practices of Organic Farming/Conservation Agriculture	3	1	4
EC-4102	Advances in Crop Production	3	1	4
EC-4103	Climate Resilient Agriculture	3	1	4
EC-4104	System Simulation and Agro-advisory	3	1	4
EC-4105	Agri-Business Management	3	1	4

EC-4106	Farm Management, Production and Resource Economics	3	1	4
EC-4107	International Trade	3	1	4
EC-4108	Agricultural Growth, Development and Policy Analysis	3	1	4
EC-4109	Economic Theory	3	1	4
EC-4110	Basic Research Methodology for Social Sciences	3	1	4
EC-4111	Soil and Water Conservation Engineering	3	1	4
EC-4112	Geoinformatics and Remote Sensing, Precision Farming	3	1	4
EC-4113	Food Science and Nutrition	3	1	4
EC-4114	Industrial and commercial Entomology	3	1	4
EC-4115	IPM and Ecology based pest management	3	1	4
EC-4116	Agricultural Journalism	3	1	4
EC-4117	Communication and information management	3	1	4
EC-4118	Emerging Trends in Agricultural Extension	3	1	4
EC-4119	Organic Livestock Farming	3	1	4
EC-4120	Climate resilient livestock production	3	1	4
EC-4121	Livestock based Integrated farming system	3	1	4
EC-4122	Micro-propagation Technologies	3	1	4
EC-4123	Molecular Diagnostics	3	1	4
EC-4124	Plant Growth Regulators	3	1	4
EC-4125	Diagnostic Physiology	3	1	4
EC-4126	Landscaping	3	1	4
EC-4127	Hi-tech Horticulture	3	1	4
EC-4128	Protected Cultivation	3	1	4
EC-4129	Post Harvest Technology and Value Addition	3	1	4
EC-4130	Commercial Plant Breeding	3	1	4
EC-4131	Biotechnology of Crop Improvement	3	1	4
EC-4132	Commercial Seed Production	3	1	4
EC-4133	Molecular Genetics and Advanced Plant Breeding	3	1	4
EC-4134	Bio-pesticides and Bio-control	3	1	4
EC-4135	Management of Natural Resources	3	1	4
EC-4136	Agrochemicals	3	1	4
EC-4137	Food Safety and Standards	3	1	4
EC-4138	Bioformulation and Nanoformulation	3	1	4
EC-4139	Biopesticides and Biofertilizers	3	1	4
EC-4140	Management of Agricultural Waste	3	1	4
EC-4141	Toxicity and Deficiency of Elements in Soil & Plant and Water Quality	3	1	4
EC-4142	Soil Quality Assessment and Management	3	1	4
EC-4143	Production, Marketing and Use of Bio-fertilizers	3	1	4
EC-4144	Chemistry of biopesticides	3	1	4
EC-4145	Statistical Methods	3	1	4
EC-4146	Experimental Designs	3	1	4
EC-4147	Sampling Techniques	3	1	4
EC-4148	Regression Analysis	3	1	4
EC-4149	Data Analysis	3	1	4
EC-4150	Indian Knowledge Systems on Plant Vitality and Consciousness	3	1	4

4th Year – VIII Semester		
Student READY		
READY-421	For B.Sc. (Hons.) Agriculture Degree Student READY: RAWE/Industrial Attachment/Experiential Learning/ Hands-on Training/ Project Work/Internship	20
Total Credit Hours		170 + 4 (Non gradial course)**
*Online courses		10
Grand Total Credit Hours		170+4**+10*

18. One credit indicates one hour lecture or two hours laboratory practical or three hours field work per week.

19. Student READY course for B.Sc. (Hons.) Agriculture Degree programme will be offered in Semester VIII and it will be conducted as per guidelines of ICAR.

20. The Foundation course on Tagore Studies (Rabindra Charcha) will be a credit course. The classes and examinations of this course will be governed by the Ordinance of Visva-Bharati.

21. The duration for semester final examination of different courses shall be as follows:

a.	Composite courses (Theory + Practical)	2 hours
b.	Only theory course	2 hours 30 minutes
c.	Practical courses	3 hours or more
d.	Student READY	4 hours or more
e.	Mid-term (Theory + Practical courses)	1 hour
f.	Mid-term (Theory courses)	1 hours 20 minutes
g.	Mid-term (Practical courses)	1 hours 20 minutes

22. Semester terminal examinations for Semester- I, III, V and VII shall normally be held in the first half of December while that for Semester – II, IV, VI and VIII shall normally be held in the first half of May in every academic year.

23. In the fifth semester, students have to participate in a compulsory Educational Tour spanning two weeks (10-14 days), designated as a non-gradial course).

24. There will be a uniform system of evaluation and grading to be followed with Grade point average (GPA) system which is presented below:

Course type	External theory	Internal theory (Mid-term)	Quiz/ progressive assessment	Final Practical
Theory + Practical courses	40%	20%	20%	20%
Only Theory courses	50%	30%	20%	-
Only Practical courses	-	30%	20%	50% (Internal)

25. The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' remark. The online/MOOC courses can be taken by a student in between Semester-IV and semester VIII of B.Sc (Honours) Agriculture course. A student must intimate and take prior permission from the Principal, Palli Siksha Bhavana regarding the said course through proper application.

26. When students take deficiency course(s), they will be assessed as 'Satisfactory' or 'Unsatisfactory' without any grade points.

27. There will be a 10-point grading system with a minimum Grade Point (GP) of 5.00 for passing a course and an Overall Grade Point Average (OGPA) of 5.00 for completing the certificate / diploma / degree programme. A candidate failing to obtain minimum GP (5.00) in not more than three courses, in a semester, will be allowed to repeat the examination of the course(s) concerned not more than three times in next available semesters. A candidate failing in more than three courses, in a semester, has to repeat the semester. But in both the cases he/she/ze has to complete the degree programme within the maximum allowable 7 years (14 semesters).

28. There shall be the provision for review system for Semester Final Theory Examination. The re-evaluation will be done internally. In any case, the first examiner should not be associated with the review process.

29.

i. The award of the divisions will be as follows:

OGPA	Division
5 to <6	Pass
6 to <7	II Division
7 to <8	I Division
≥8	1st Division with Distinction

ii. A candidate failing to obtain a minimum OGPA of 5.00 will not be considered for the award of the degree and shall be declared as failed.

iii. The evaluation will be done on a 10-point scale. 10 point = 100 marks. The per cent of marks in a subject will be divided by 10 to obtain the grade point. The grade point average for a semester will be calculated as follows:

$$\text{GPA} = \frac{\sum(\text{Grade Point} \times \text{Credit hours}) \text{ in one semester}}{\text{Total credit hours in the semester}}$$

iv. The Cumulative grade point earned at any stage of the course will be calculated as cumulative grade point average (CGPA) as follows:

$$\text{CGPA} = \frac{\sum(\text{Grade Point} \times \text{Credit hours}) \text{ until last semester}}{\text{Total credit hours until last semester}}$$

30. All the students shall be required to register themselves for appearing in the examinations as per Visva-Bharati norms. Each student shall submit a roster in the prescribed form indicating the courses opted to the Principal, Palli Siksha Bhavana at the beginning of each semester.

31. The students seeking admission to each Semester Final Examination of the B.Sc. (Honours) Agriculture course shall:

i. Produce a certificate from the Principal, Palli Siksha Bhavana that he/she/ze has attended at least 75% of the in–campus classes in each semester. However, relaxation allowed (if any) will be guided by the Ordinance of Visva-Bharati.
ii. Produce a certificate from the Principal, Palli Siksha Bhavana that his/her conduct has been good and that he/she/ze is a fit and proper candidate for the examination; and
iii. Pay examination fees as decided by the University.

32. If a student fails to complete a semester for exigencies beyond his/her control he/she/ze will be allowed to repeat the semester within the maximum allowable semesters provided he/she/ze intimates beforehand regarding the absence from the semester to the Principal, Palli Siksha Bhavana with a proper application. However, he/she/ze has to complete all the courses within the maximum allowable semesters i.e., 14 semesters (7 years).

33. There shall be the provision for review of answer scripts for Semester Terminal theory Examination as per university rule.

34. The medium of instruction and examination shall be English.

35. There shall be a Course Leader in each course who besides teaching the course will co-ordinate various activities of the particular course. The Principal, Palli Siksha Bhavana will nominate the Course Leaders in consultation with concerned Head of the Departments.

36. There shall be a UG Course Coordinator who will co-ordinate various activities of the B. Sc. (Honours) Agriculture Programme, UG-Diploma in Agriculture, and UG-Certificate course in Agriculture. In addition to the UG Course Coordinator, there shall be one Coordinator for student READY programme who will co-ordinate student READY programmes and other out campus activities in consultation with the Principal, Palli Siksha Bhavana and the UG Course Coordinator. The Principal, Palli Siksha Bhavana will nominate the UG Course Coordinator and student READY Coordinator in consultation with Heads of the Departments, Palli Siksha Bhavana.

37. Paper setting and evaluation of semester terminal examinations:

(i) Question papers for semester final Theory examination will be set by external examiners and evaluation to be done by internal examiners.

(ii) Moderation of question papers for the semester final theory examinations shall be done by a committee appointed as per university rules including external moderator(s).

(iii) Practical component of courses will be conducted and evaluated internally by course instructor(s).

(iv) Evaluation of RAWE & AIA will be done by an examination committee comprising of the respective Coordinators and component-in-charge Instructor.

(v) The evaluation of internship will be done both by Palli Siksha Bhavana and the host industry/organisation. It will be of 50% weightage for each. The student shall submit a report to Palli Siksha Bhavana and present the

learnings before the other students and faculty after the internship programme. The evaluation will be as per the format developed by Palli Siksha Bhavana.

DETAILED SYLLABI

Semester I

IFC-111	Deeksharambh (Induction-cum-Foundation Programme)	0+2 (NG)

Objective

- To give a broad view and application areas of the subject of study
- Helping students from different backgrounds for cultural Integration
- Knowing about the operational framework of academic process in university
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

Activities

The details of activities/schedules will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
ii. Creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario
iii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
iv. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
v. Field visits to related fields/ establishments
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

AEC-111	Communication Skills	1+1

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/ Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions. Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events

Suggested readings

1. Allport, G. W. 1937. Personality: A Psychological Interpretation. Holt, New York.

2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter, S. J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi. 5. Kumar, S. and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James, W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman, M. and Singh, P. 2000. Business Communication. Oxford University Press.
9. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford University

MDC-111	Farming based Livelihood Systems	2+1

Objective

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and in West Bengal, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approaches and framework, Definition of farming systems and farming based livelihood systems. Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (Dairy, Piggery, Goatery, Poultry, Duckery etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large-enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in nearby villages, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors. Case studies on different livelihood enterprises associated with the farming.

Suggested Readings

1. Dixon, J. and A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA
2. Ashley, C.; Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7. [Google Scholar]
3. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
4. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
5. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
6. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.
7. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K.

Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna 800 014, Bihar.
8. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
9. Evenson, R.E. 2000. Agricultural Producitivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
10. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India

AEX-111	Rural Sociology and Educational Psychology	2+0

Objective
Provide knowledge on concept and importance of sociology and rural sociology as well as the relationship with Extension Education

Theory
Extension Education and Agricultural Extension: Meaning, definition, scope, and importance. Sociology and rural sociology: Meaning, definition, scope, importance of rural sociology in Agricultural Extension, and interrelationship between rural sociology and Agricultural Extension. Indian Rural Society: important characteristics, differences and relationship between rural and urban societies. Social Groups: Meaning, definition, classification, factors considered information and organization of groups, motivation in group formation and role of social groups in Agricultural Extension. Social Stratification: Meaning, definition, functions, basis for stratification, forms of social stratification-characteristics and- differences between class and caste system. Cultural concepts: culture, customs, folkways, mores, taboos, rituals. Traditions: Meaning, definition and their role in Agricultural Extension. Social Values and Attitudes: Meaning, definition, types and role of social values and attitudes in agricultural Extension. Social Institutions: Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension. Social Organizations: Meaning, definition, types of organizations and role of social organizations in agricultural Extension. Social Control: Meaning, definition, need of social control and means of social control. Social change: Meaning, definition, nature of social change, dimensions of social change and factors of social change. Leadership: Meaning, definition, classification, roles of leader, different methods of selection of professional and lay leaders. Training of Leaders: Meaning, definition, methods of training, Advantages and limitations in use of local leaders in Agricultural Extension, Psychology and educational psychology: Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. Intelligence: Meaning, definition, types, factors affecting intelligence and importance of intelligence in Agricultural Extension. Personality: Meaning, definition, types, factors influencing the personality and role of personality in agricultural Extension. Teaching: Learning process: Meaning and definition of teaching, learning, learning experience and learning situation, elements of learning situation and its characteristics. Principles of learning and their implication of teaching.

Suggested readings
1. A. R. Desai -Rural Sociology in India
2. Dahama O. P. and Bhatnagar, O. P. - Education and Communication for Development
3. J.B. Chitambar -Introductory Rural Sociology
4. M.B. Ghorpade- Essential of psychology
5. Prepared You Tube videos
6. R Velusamy Textbook on Rural Sociology and Educational Psychology
7. Ray, G. L. -Extension Communication and Management
8. Sandhu A. S. -Textbook on Agricultural Communication
9. Web Materials

AGR-111	Fundamentals of Agronomy	2+1

Objectives
To impart the basic and fundamental knowledge of Agronomy

Theory
Agronomy and its scope: Definition, meaning and scope of Agronomy; art, science and business of crop production, relation of Agronomy with other disciplines of Agricultural Science, fields crops and

classification, importance, ecology and ecosystem. Seeds and sowing: Definitions of crops, variety and seed. Factors affecting crop stands establishment: good quality seed, proper tillage, time of sowing seed rate, depth and method of sowing: broadcasting, drilling, dibbling, transplanting etc. Tillage and tilth: Definition, objectives, types, advantages and disadvantages of tillage including conservation tillage. Crop density and geometry: plant geometry and planting geometry, its effect on growth, yield.

Crop nutrition: Definition of essential nutrients, criteria of essentiality, functional elements, classification of essential nutrients, role of macro and micro nutrients. Nutrient absorption, active and passive absorption of nutrients, forms of plant nutrients absorbed by plants, Combined /uncombined forms. Manures and fertilizers, nutrient use efficiency: Sources of nutrients: Inorganic(fertilizers), organic (manures) and bio-fertilizers; their classification and characteristics, method of preparation and role of organic manures in crop production. Integrated Nutrient Management (INM): Meaning, different approaches and advantages of INM. Green manure- role in crop production: Definition, objectives types of green manuring, desirable characteristics, advantage sand limitations of green manuring. Water management: Water resources of the world, India and the state; Soil Moisture constants: gravitational water, capillary water, hygroscopic water, Soil moisture constants. Weeds: Definition, Importance and basics of classification of weeds and their control. Agroclimatic zones of India and the state, cropping systems: Factors affecting cropping systems, major cropping patterns and systems in the country. Sustainable crop production: Definition, importance and practices, natural resources and conservation pollution and pollutants, Allelopathy: Meaning and importance in crop production, Growth and development of crops: Definition, Meaning and factors affecting growth and development.

Practical

A visit to Instructional Crop farm and study on field crops, Identification of crops, seeds, fertilizers, pesticides, Crops and cropping systems in different Agro-climatic zones of the state, Study of some preparatory tillage implements, Study of inter tillage implements, Practice of ploughing/puddling, Study and practice of inter cultivation in field crops, Numerical exercises on calculation of seed, plant population and fertilizer requirement, Study of yield contributing characters and yield estimation of crops, Identification of weeds in different crops, Seed germination and viability test of seed, Practice on time and method of application of manures and fertilizers.

Suggested readings

1. Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
2. Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.
3. Reddy, S. R. 2008. Principle of Crop Production, Kalyani Publisher, Ludhiana.
4. William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
5. Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.

SSC-111	**Fundamentals of Soil Science**	**2+1**

Objective

To impart knowledge on soil genesis, basic soil properties with respect to plant growth.

To enlighten students about ancient glory of India in river-based civilization, restoration of soil fertility by ancient Indian knowledge system

Theory

Soil: Pedological and edaphalogical concepts. Rocks and minerals, weathering, Silicate clays: constitution and properties, sources of charge, ion exchange, cation and anion exchange capacity and base saturation (after buffering capacity), Soil formation, Soil organic matter, Pedogenic processes, Soil colloids: inorganic and organic, Properties of soil colloids and Ion exchange in soils, Soil profile, soil texture, soil structure. Bulk density and particle density, soil consistency, soil temperature, soil air, soil water. Soil reaction and buffering capacity. Soil taxonomy, keys to soil orders. Soils of India.

Historical aspects of Indian civilization and soil fertility management using ancient Indian knowledge system like shifting cultivation, restoration of soil fertility and controlling land degradation by use of organic amendments. Indigenous soil classifications (e.g., urvara, ushara) based on colour, texture, and fertility; linking with modern pedological and edaphological concepts. Sustainable soil

management using organic inputs (e.g., cow dung slurry, panchagavya, jeevamrut) and field-based soil health indicators like earthworms.

Practical
Study of general properties of minerals, study of minerals-silicate and non-silicate minerals, study of rocks-igneous, sedimentary and metamorphic rocks; study of a soil profile, collection and processing of soil for analysis, study of soil texture-feel method, mechanical analysis, determination particle density and soil porosity, determination of soil colour, study of soil structure and aggregate analysis, determination of soil moisture, determination of soil moisture constants field capacity; water holding capacity. Study of infiltration rate of soil, determination of pH and Electrical conductivity of soil.
Practical on traditional methods for assessing soil colour and texture. Studying the use of indigenous organic amendments (e.g., cow dung slurry, panchagavya, jeevamrut) and their effects on soil properties. Observation on traditional soil health indicators like the presence of earthworms.

Suggested readings
1. Introductory Soil Science – By Dilip Kumar Das, Kalyani Publishers
2. Soil Fertility and Nutrient Management – By S. S. Singh, Kalyani Publishers
3. Soil Fertility and Fertilizers – By Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York
4. The Nature and Properties of Soils – By Harry O. Buckman and Nyle C.

HOR-111	Fundamentals of Horticulture	2+1

Objectives
1. To provide knowledge on different branches of horticulture viz. pomology, olericulture, floriculture and landscaping, spices and medicinal plants
2. To provide knowledge on orchard management, propagation methods, cultural operations and nutrient management of horticultural crops
3. To provide knowledge on different physiological aspects of horticultural crops

Theory
Horticulture: Its different branches, importance and scope, Horticulture and botanical classification, soil and climate for horticultural crops. Plant propagation: methods and propagation structures, seed dormancy and seed germination, Merits and demerits of sexual and asexual propagation Stock-scion relationship. Principles of orchard establishment, principles and methods of training and pruning of fruit crops, Juvenility and flower bud differentiation, unfruitfulness in horticultural crops, pollination, pollinizers and pollinators, fertilization and parthenocarpy, importance of bio regulators in horticultural crops, irrigation and its methods, Fertilizer application in horticultural crops.

Practical
Identification and nomenclature of fruit, Layout of an orchard, pit making and system of planting, Nursery raising techniques of fruit crops, Understanding of plant propagation structures, Propagation through seeds and plant parts, Propagation techniques for horticultural crops, Container, potting mixture, potting and repotting, Training and pruning methods on fruit crops, Preparation of fertilizer mixture and application, Preparation and application of PGR, Layout of different irrigation systems, Maturity studies, harvesting, grading, packaging and storage.

Suggested readings
1. Basics of Horticulture by Jitendra Singh
2. Introduction to Horticulture by N. Kumar
3. Handbook of Horticulture by ICAR

AEC-112	National Service Scheme (NSS)	0+1

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.
All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV; each having one credit load.

The entire four courses should be offered continuously for two years. A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peacebuilding. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

RC-111	Introductory Mathematics (need based)	1+0(NG)

Theory:

Algebra: Progressions- Arithmetic, Geometric and Harmonic Progressions. Matrices: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation. Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation- Growth rate, Average Cost, and Marginal cost, Marginal Cost, Marginal Revenue. Partial differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form y = f (x) and y = f (x1, x2). Integral Calculus: Integration -Definite and Indefinite Integrals- Methods- Integration by substitution, Integration by parts. Area under simple well-known curves. Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Semester II

AEC-121	Personality Development	1+1

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour. Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and

Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behaviour.

Suggested reading

1) Andrews, Sudhir. 1988. How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGrawHill.
2) Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3) Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4) Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House Lucas, Stephen. 2001. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5) Mile, D.J. 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
6) Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
7) Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor

VAC-121	**Environmental studies and disaster management**	**2+1**

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art – skilland expertise on management of disasters

Theory

Introduction to Environment - Environmental studies: Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth- Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Soil resources. Ecosystems: Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and 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 h. Light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: 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. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Importance of Indian knowledge system in sustainable development.

Disaster management: Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management. Indian knowledge system for Disaster Risk Reduction.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in

water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disasters. Study of traditional Indian knowledge for resource management and disaster risk reduction.

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T., Vennila, S., Prasanthrajan, M. Umesh and Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi
5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur
6. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerat, India
7. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

SSC-121	Soil Fertility Management	2+1

Objective

To provide a comprehensive knowledge of soil fertility, plant nutrition, fertilizers, and nutrient management

To offer valuable insights into different indigenous techniques in soil fertility management

Theory

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 macro 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. Introduction and importance of manures and fertilizers. Fertilizer recommendation approaches. Integrated nutrient management. Chemical fertilizers: classification, composition and properties of major fertilizers, secondary and micronutrient fertilizers, Complex fertilizers, Customised fertilizers, water soluble fertilizers nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions. STCR/RTNM/IPNS, Carbon sequestration and Carbon Trading, Preparation and properties of major manures (FYM, Compost, Vermicompost, Green manuring, Oilcakes).

Restoration of Soil fertility through crop rotation, intercropping, integration of livestock, agroforestry and use of different formulations like Kanupajala, cow dung, sheep manure, poultry manure and inoculation of vergin soil from previous cultured soil etc Indigenous knowledge on soil fertility and plant nutrition through ancient Indian texts like Vrikshayurveda and Krishi-Parashara; Traditional methods of applying panchagavya, green manure, compost etc for upkeeping soil health. Location and time-specific nutrient management practices.

Practical

Introduction of analytical instruments and their principles, calibration and applications of Colorimetry and flame photometry; Estimation of alkaline hydrolysable N in soils; Estimation of soil extractable P in soils; Estimation of exchangeable K in soils; Estimation of exchangeable 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. Comparative analysis of traditional and modern organic amendments. Indigenous method of preparation of panchagavya and its impact on soil fertility parameters.

Suggested readings

1. Introductory Soil Science by Dilip Kumar Das, Kalyani Publishers
2. Soil Fertility and Nutrient Management by S. S. Singh, Kalyani Publishers
3. Soil Fertility and Fertilizers by Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York
4. The nature and Properties of Soils by Harry O. Buckman and Nyle C.

AEN-121	Fundamentals of Entomology	2+1

Objectives

1. To know the history of entomology, classification of insects and their relationship with other arthropods
2. To study the various morphological characters of class insect and their importance for classification of insects
3. To get an idea about the different physiological systems of insects and their roles in growth and development and communications of insects
4. To study the characteristics of commonly observed insect orders and their economically important families

Theory

History of Entomology in India. IKS: Ancient historical evidence of entomological studies in India. Major points related to dominance of Insects in Animal kingdom. Classification of phylum Arthropoda up to classes. Relationship of class Insects with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs. Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors and biotic factors. Categories of pests. Systematics: Taxonomy – importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta up to Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigoniidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

Suggested readings

1. Fundamentals of Ecology - Eugene. P. Odum and Gray W. Barrett
2. Imm's General Text book of Entomology— O.W. Rechards and R.G. Davies
3. Introduction to the study of Insects –D. J. Borror and DeLong's

ANS-121	Livestock and poultry Management	1+1

Objectives

1. Provide basic knowledge to the students about scientific livestock and poultry rearing practices
2. Introduction to the principles and practices of Indian Knowledge Systems (IKS) in livestock and poultry management.
3. Entrepreneurship development through Livestock/poultry and Agriculture Integrated Farming System

Theory

Role of livestock in the national economy. Livestock in Indian Knowledge Systems (IKS): Cultural, Ecological and Sustainable Perspectives. Important Indian and exotic breeds of cattle, buffalo, sheep,

goat, swine and poultry. Conservation of Indigenous Livestock and Poultry Breeds through Indian Knowledge Systems (IKS). Improvement of farm animals and poultry. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Application of Indian Knowledge Systems in Sustainable Livestock and Poultry Housing Practices. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. Traditional Feeding Strategies for Livestock and Poultry: An IKS Perspective. Introduction of livestock and poultry diseases. Indian Knowledge System (IKS) in livestock and poultry disease management. Integration of Indian Knowledge System (IKS) with Modern Veterinary Practices for prevention 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 equipment. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production

Suggested Readings

1. A Textbook of Animal Husbandry by G. C Banerjee
2. A text Book of Livestock Production management in Tropic by D. N. Verma
3. Traditional Knowledge in Agriculture by Mishra, Anupam, Singh, S.R.K., Raut, A.A. (2020). Division of Agricultural Extension, ICAR, New Delhi.
4. Ethnoveterinary medicine in India by Jarra Koteswara Rao and T.V.V. Seetharami Reddi

PPC-121	Fundamentals of Plant Pathology	2+1

Objectives

1. To get acquainted with the role of different microorganisms in the development of plant disease
2. To get general concepts and classification of plant diseases
3. To get knowledge of general characteristics of fungi, bacteria, virus, and other microorganisms causing plant diseases
4. To acquaint the students with reproduction in fungi, and bacteria, causing plant diseases
5. To get acquainted with various plant disease management principles and practices

Theory

Introduction to Plant Pathology: Concept of disease in plants; Different terms used in Plant Pathology, Indigenous knowledge regarding plant diseases and their management in different ancient Indian literature, History of Plant Pathology with special references to India; Causes of plant disease: Inanimate and animate causes; Classification of plant disease; Parasitism and pathogenesis; Development of disease in plants: Disease Triangle, Disease cycle; Fungi and their morphology, reproduction and classification of fungi; Bacteria: Morphology, reproduction classification of phytopathogenic bacteria; Other plant pathogens: Mollicutes; Flagellant protozoa; FVB; Green algae and parasitic higher plants; Viruses and viroids, virus transmission; Principles of Plant disease management: Disease management with chemicals, Host resistance, cultural and biological method of Integrated Disease Management (IDM).

Practical

Study of the microscope; Acquaintance with laboratory material and equipment; Study of different plant disease symptoms; Microscopic examination of general structure of fungi; Simple staining of bacteria: Direct and indirect staining, Gram staining of bacteria; Microscopic examination of fungal diseased specimen; Microscopic examination of bacterial diseased specimen; Preparation of culture media; Isolation of plant pathogens: Fungi, bacteria and viruses; Purification of plant pathogens; Study on plant disease diagnosis: Koch's Postulates, Characteristics, formulation, methods of application and calculation on fungicides.

Suggested readings

1. Agrios, G.N. 2010. Plant Pathology. Acad. Press.
2. Alexopoulos, Mims and Blackwel. Introductory Mycology.
3. Dhingra, O.D. and Sinclair, J.B. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo.
4. Gibbs, A. and Harrison, B. 1976. Plant Virology - The Principles. Edward Arnold, London
5. Goto, M. 1990. Fundamentals of Plant Bacteriology. Academic Press, New York.
6. Hull R. 2002. Mathew's Plant Virology. 4th edn. Academic Press, New York.
7. Kamat, M. N. Introductory Plant Pathology. Prakash Pub, Jaipur.
8. Mehrotra, R.S. and Aggarwal, A. 2007. Plant Pathology. 7th edn. Tata Mc Graw Hill Publ. Co. Ltd.
9. Nene, Y.L. and Thapliyal, P.N. 1993. Fungicides in Plant Disease Control. 3rd Ed. Oxford & IBH, New Delhi.
10. Pathak, V. N. Essentials of Plant Pathology. Prakash Pub., Jaipur
11. Rajeev, K. and Mukherjee, R.C. 1996. Role of Plant Quarantine in IPM. Aditya Books.
12. Rhower, G.G. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2nd edn. Vol. II. (Ed. David Pimental). CRC Press.
13. Singh R.S. 2008. Plant Diseases. 8 th Ed. Oxford & IBH. Pub. Co.
14. Singh R.S. 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co.
15. Verma, J.P. 1998. The Bacteria. Malhotra Publ. House, New Delhi.
16. Vyas SC. 1993. Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

AEC-122	National Service Scheme (NSS)	0+1

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Semester III

MDC-211	Entrepreneurship Development and Business Management	2+1

Objective

1. To provide student an insight into the concept and scope of entrepreneurship.
2. To expose the student to various aspects of establishment and management of a small business unit.
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment–identification of product/service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product/services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management–manpower

planning, labour turn over, wages / salaries. Financial management/accounting–funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management-market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical
Visit to small scale industries/agro-industries, interaction with successful entrepreneurs/agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

- Charantimath P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
- Desai, V. 2015. Entrepreneurship: Development and Management, Himalaya Publishing House.
- Desai, Vasant. 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
- Grover, Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
- Gupta, C.B. 2001. Management Theory and Practice. Sultan Chand & Sons.
- Khanka, S.S. 1999. Entrepreneurial Development. S. Chand & Co.
- Mehra, P. 2016. Business Communication for Managers. Pearson India, New Delhi.
- Pandey, M. and Tewari, D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
- Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
- Singhal, R.K. 2013, Entrepreneurship Development & Management, Katson Books.
- Tripathi, P.C. and Reddy, P.N. 1991. Principles of Management. Tata McGraw Hill.

AEC-211	Physical Education, First Aid, Yoga Practice and Meditation	0+2

Objectives
1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical
Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga:
- Asanas: Definition and Importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan– left legright leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports • Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with

Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

GPB-211	**Principles of Genetics**	**2+1**

Objective

To make the students acquainted with both principles and practices in the areas of classical genetics, modern genetics, quantitative genetics and cytogenetics.

Theory

Pre and post Mendelian concepts of heredity, Mendelian principles of heredity including brief reference to ancient Indian understanding of heredity and resemblance (e.g., from texts like *Charaka Samhita* and *Manu Smriti*) where concepts of parental resemblance, lineage (*gotra*), and traits passed across generations were mentioned, Study of model organisms (Drosophila, Arabidopsis, Garden pea, E. coli, and mice), Architecture of chromosomes, chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere, special types of chromosomes, Chromosomal theory of inheritance- cell cycle and cell division-mitosis and meiosis with brief relation to the ancient Indian cyclic view of life and matter (e.g., *Sankhya* philosophy), which describes transformation and replication-like processes, though metaphysical . Probability and Chi-square. Types of DNA and RNA, Dominance relationships, Epistatic interactions with example, Introduction and definition of cytology, genetics and cytogenetics and their interrelation. Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics with special reference to ancient Indian caste-based blood purity beliefs and how modern genetics refuted any biological basis of such distinctions, Linkage and its estimation, crossing over mechanism, chromosome mapping, Structural and numerical variations in chromosomes and their implications, Use of haploids, dihaploids and double haploids in Genetics, Mutation, classification, Methods of inducing mutations, mutagenic agents and induction of mutation including the concept of spontaneous changes and metaphysical explanations in Indian philosophies regarding variation and individuality. Qualitative and quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance, Nature, structure and replication of genetic material, Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation.

Practical

Study of microscope, Study of cell structure, Mitosis and Meiosis cell division, Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and chi-square test, Determination of linkage and croo-over analysis (through two point test cross data), Study on sex linked inheritance in Drosophila. Study on models on DNA and RNA structures.

Suggested readings

1. Fundamentals of Genetics: B. D. Singh
2. Genetics: M. W. Strickberger.
3. Principles of Genetics: Gardner, Simmons and Snustad.
4. Principles of Genetics: Sinnott, Dunn and Dobzhansky

AGR-211	**Crop Production Technology-I (*Kharif* crops)**	**1+2***

Objectives

1. To impart basic and fundamental knowledge on principles and practices of kharif crop production
2. To impart knowledge and skill on scientific crop production and management

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals- rice, maize, sorghum, pearl millet, finger millet and other minor millets, pulses - pigeonpea, mungbean and urdbean; oilseeds - groundnut, soybean, sesame, castor; fibre crops - cotton and jute; forage crops - sorghum, cowpea, cluster bean, maize, guinea and napier. Indian knowledge system regarding *kharif* crop cultivation.

Practical
Rice nursery preparation, transplanting of rice, sowing of soybean, pigeon pea and mungbean, maize, groundnut and cotton, effect of seed size on germination and seedling vigour of *Kharif* crops, effect of sowing depth on germination of *Kharif* crops, identification of weeds in *Kharif* crops, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of *Kharif* crops, study of crop varieties and important agronomic experiments at experiential farm, recording biometric observations, Study of forage experiments, morphological description of *Kharif* crops, silage and hay making, visit to research centres of related crops. Indian knowledge system regarding *kharif* crop cultivation.

***Practical Crop Production- One (1) credit from practical of the course is allotted for Practical Crop Production of selected *kharif* crops covered under this course.**

Suggested Readings

1. B. Gurarajan, R. Balasubramanian and V. Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
2. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
4. S.R. Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
5. S.S. Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
6. UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.
7. Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production. South Asian Publishers, New Delhi.

HOR-211	Production Technology of Fruit and Plantation Crops	1+1

Objectives
1. To educate about the different forms of classification of fruit crops
2. To educate about the origin, area, climate, soil, improved varieties and cultivation practices of fruit and plantation crops
3. To educate about the physiological disorders of fruit crops, palms and plantation crops

Theory
Production status of fruit and plantation crops: Importance and scope of fruit and plantation crop industry in India; nutritional value of fruit crops; classification of fruit crops; area, production, productivity and export potential of fruit and plantation crops. Crop production techniques in tropical, sub-tropical and temperate fruit crops: Climate and soil requirements, varieties, propagation and use of rootstocks, planting density and systems of planting: High density and ultra-high density planting, cropping systems, after care – training and pruning; water, nutrient and weed management, fertigation, special horticultural techniques, plant growth regulation, important disorders, maturity indices and harvest, value addition.
Fruit crops: mango, banana, papaya, guava, sapota, citrus, grape, litchi, pineapple, pomegranate, apple, pear, peach, strawberry, nut crops Jackfruit and minor fruits- date, ber, apple, plantation crops- coconut, arecanut, cashew, tea, coffee and rubber.
Crop production techniques in palms and plantation crops: Climate and soil requirements, varieties, propagation, nursery management, planting and planting systems, cropping systems, after care, training and pruning for plantation crops, water, nutrient and weed management, intercropping, multi-tier cropping system, mulching, special horticultural practices, maturity indices, harvest and yield, pests and diseases, processing- value addition
Palms: Coconut, Arecanut, Oil palm and Palmyrah, Plantation crops: Tea, Coffee, Cocoa, Cashewnut, Rubber.

Practical
Propagation techniques, selection of planting material, varieties, important cultural practices for mango, banana, papaya, guava, sapota, grapes, Citrus (mandarin and acid lime), pomegranate, jackfruit, preparation and application of PGR's for propagation, Micro propagation, protocol for mass multiplication and hardening of fruit crops, Identification and description of varieties, mother palm and seed nut selection, nursery practices, seedling selection, fertilizers application, nutritional disorders,

pests and diseases of Coconut, Arecanut and cocoa, Tea and coffee, Rubber and cashew, Visit to commercial orchard and plantation industries.

Suggested Readings

1. Banday, F.A. and Sharma, M.K.2010 Advances in temperate fruit production. Kalyani Publishers, Ludhiana
2. Bose, T.K., S.K. Mitra and D. Sanyal 2001. Fruits: Tropical and Subtropical (2 volumes) Naya Udyog, Calcutta.
3. Bose, T.K., S.K. Mitra, A.A. Farooqi and M.K. Sadhu (Eds). 1999. Tropical Horticulture Vol.1. Naya Prokash, Calcutta.
4. Chadha, K.L. 2001. Handbook of Horticulture. ICAR, Delhi
5. Chadha, T.R. 2001 Textbook of temperate fruits. ICAR, New Delhi
6. Chattopadhyay, T.K. 2001. A Text Book on Pomology (4 volumes). Kalyani Publishers, Ludhiana.
7. Chattopadhyay. 1998. A textbook on pomology (sub-tropical fruits) vol.III. Published by M/s. Kalyani publishers, Ludhiana, New Delhi, Noida. UP.
8. Chudawat, B. S.1990. Arid fruit culture Oxford &IBH, New Delhi
9. Das, B.C. and Das S.N. Cultivation of minor fruits. Kalyani Publishers, Ludhiana
10. David Jackson and N.E. Laone, 1999. Subtropical and temperate fruit production. CABI publications
11. H.P. Singh and M.M. Mustafa 2009. Banana-new innovations Westville publishing House, New Delhi
12. Kumar, N. 1997. Introduction to Horticulture. Rajalakshmi Publications, Nagercoil, Tamil Nadu.
13. Mitra, S.K., T.K. Bose and D.S. Rathore. 1991. Temperate fruits. Horticulture and allied Publishers, Calcutta.
14. Pal, J.S. 1997. Fruit Growing. Kalyani Publishers, New Delhi.
15. Radha, T. and Mathew, L.2007. Fruit crops. New India publishing Agency
16. Rajput, CBS and Srihari babu, R.1985. Citriculture, Kalyani Publishers, Ludhiana
17. Sadhu, M.K. and P.K. Chattopadhyay. 2001. Introductory Fruit Crops. Naya Prokash, Calcutta.
18. Singh, S.P. 2004. Commercial Fruits. Kalyani Publishers, Ludhiana
19. Symmonds. 1996. Banana, II Edn.Longman, London
20. Veeraragavathatham, D., Jawaharlal, M., Jeeva, S., Rabindran, R and Umapathy, G. 2004 (2nd edition). Scientific fruit culture. Published by M/s. Suri associates, 1362/4, Velraj Vihar Complex, Thadagam Road, Coimbatore- 2
21. W.S. Dhillon. 2013. Fruit production in India. Narendra publishing House, New Delhi
22. Kavino, M, V. Jegadeeswari, R. M. Vijayakumar and S. Balkrishnan. 2018. Production Technology of Fruits and Plantation Crops by Narendra Publishing House.
23. Kumar, N.J. B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to spices, Plantation crops and Aromatic plants. Oxford & IBH, New Delhi.
24. Nair. 1979. Cashew, CPCRI, Kerela
25. Sharma, A., Kumar, P., Tripathi, V.K. 2024. Production Technology of Fruits and Plantation Crops. Elite Publishing House
26. Thampan, P.K.1981. Handbook of coconut palm. Oxford &IBH, New Delhi.
27. Thompson, P.K.1980. Coconut. Oxford &IBH, New Delhi
28. V. Ponnuswami, M. Kumar; S. Ramesh Kumar and C. Krishnamoorthy 2015. Fruit and Plantation Crops Narendra Publishing House.

AEX-211	Fundamentals of Extension Education	1+1

Objectives

1. State the importance of extension education in agriculture
2. Familiarize with the different types of agriculture and rural development programs launched by govt. of India
3. Classify the types of extension teaching methods
4. Elaborate the importance and different models of communication
5. Explain the process and stages of adoption along with adopters' categories

Theory

Education: Meaning, definition and 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.);

Reorganised Extension System (T&V system) various extension/ agriculture development programs launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP, etc.). Social Justice and poverty alleviation programme: ITDA, IRDP/SGSY/NRLM. Women Development Programme: RMK, MSY etc. New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc., Attributes of Innovation, DWCRA, Commodity Interest Groups (CIGs)., Farmers Producer Group (FPG).
Rural Development: concept, meaning, definition; various rural development programs launched by Govt. of India. Community Development: meaning, definition, concept and principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; Method of identification of Rural Leader. Extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programs; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and social media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical
To get acquainted with university extension system. Group discussion- exercise; Identification of rural leaders in village situation; preparation and use of AV aids, preparation of extension literature (leaflet, booklet, folder, pamphlet news stories and success stories); Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA/PRI and other development departments at district level; visit to NGO/FO/FPO 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.

Suggested readings

1. Adivi Reddy, A. 2001. Extension Education, Sree Lakshmi press, Bapatla.
2. Dahama, O. P. and Bhatnagar, O.P. 1998. Education and Communication for Development, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
3. Jalihal, K. A. and Veerabhadraiah, V. 2007. Fundamentals of Extension Education and Management in Extension, Concept publishing company, New Delhi.
4. MuthaiahManoraharan, P. and Arunachalam, R., Agricultural Extension, Himalaya Publishing House (Mumbai).
5. Sagar Mondal and Ray, G. L., Text Book on Rural Development, Entrepreneurship and Communication Skills, Kalyani Publications.
6. Rathore, O. S. et al. 2012. Handbook of Extension Education, Agrotech Publishing Academy, Udaipur.
7. Dudhani, C.M., Hirevenkatgoudar, L.V., Manjunath, L. Hanchinal, S.N. and Patil, S.L. 2004. Extension Teaching Methods and Communication Technology, UAS, Dharwad.
8. Sandhu, A.S. 1993. Text book on Agricultural Communication: Process and Methods. Oxford and IBH Publishing Pvt. Ltd, New Delhi.
9. Singh, A.K., Lakhan Singh, R. and Roy Burman. 2006. Dimensions of Agricultural Extension.Aman Publishing House, Meerut

PPC-211	Fundamentals of Nematology	1+1

Objectives
1. To impart knowledge on history, economic importance of plant parasitic nematodes, morphology, biology, host parasitic relationship of nematodes.
2. To impart knowledge on nematode pests of different crops of national and local importance and their management.

Theory
Introduction: Ancient Indian knowledge on nematodes. History of phytonematology, habitat and diversity, economic importance of nematodes. General characteristics of plant parasitic nematodes. Nematode: definition, general morphology and biology. Classification of nematodes up to family level

with emphasis on groups containing economically important genera. Classification of nematodes on the basis of feeding/parasitic habit. Symptomatology, role of nematodes in disease development, Interaction between plant parasitic nematodes and disease-causing fungi, bacteria and viruses. Nematode pests of crops: Rice, wheat, vegetables, pulses, oilseed and fiber crops, citrus and banana, tea, coffee and coconut. Different methods of nematode management: Cultural methods, physical; methods, Biological methods, Chemical methods, Plant Quarantine, Plant resistance and INM. IKS - Management of Nematode diseases through available indigenous knowledge system and locally adopted cultural methods.

Practical
Sampling methods, collection of soil and plant samples; Extraction of nematodes from soil and plant tissues following Cobb's sieving and decanting technique, Baermann funnel technique, Picking and counting of plant parasitic nematode. Identification of economically important plant nematodes up to generic level with the help of keys and description: Meloidogyne, Pratylenchus; Heterodera, Tylenchulus, Xiphinema, and Helicotylenchus etc. Study of symptoms caused by important nematode pests of cereals, vegetables, pulses, plantation crops etc. Methods of application of nematicides and organic amendments.

Suggested readings
1. Economic Nematology-Edited by J.M. Webster
2. Plant Parasitic Nematodes (Vol-1) by Zukerman, Mai, Rohde
3. Plant Parasitic Nematodes of India: Problems and Progress by - Gopal Swarup, D. R. Dasgupta, P. K. Koshy.
4. Text book on Introductory Plant Nematology -R.K. Walia and H.K. Bajaj.

AGR-212	**Principles and Practices of Natural Farming**	**1+1**

Objectives
1. To provide comprehensive understanding and knowledge to students about natural farming.
2. To teach students the concept, need and principles of native ecology-based production under natural farming.
3. To impart practical knowledge of natural farming and related agricultural practices in Indian and global environmental and economic perspectives.

Theory
Indian Heritage of Ancient Agriculture, History of Natural Farming, Importance of natural farming in view of climate change, soil health, water use carbon sequestration, biodiversity conservation, food security and nutritional security, and sustainable development goals (SDGs), Concept, definition, objectives and scope of natural farming, Essential characteristics and principles of natural farming. Main Pillars of natural farming; Methods/ types/schools of natural farming. Characteristics and design of a natural farm, Concept of ecological balance, ecological engineering and community responsibility in natural versus other farming systems. Introduction to concept of ecological, water, carbon and nitrogen foot prints. Concept and evaluation of ecosystem services, integration of crops, trees and animals, cropping system approaches, biodiversity, indigenous seed production, farm waste recycling, water conservation and renewable energy use approaches on a natural farm, Rearing practices for animals under natural farming, Nutrient management in natural farming and their sources, Insect, pest, disease and weed management under natural farming; Mechanization in natural farming, Processing, labelling, economic considerations and viability, certification and standards in natural farming, marketing and export potential of natural farming produce and products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of natural farming and chemical free agriculture, Entrepreneurship opportunities in natural farming.

Practical
Visit of natural farm and chemical free traditional farms to study the various components and operations of natural farming principles at the farm; Indigenous technical knowledge (ITK)for seed, tillage, water, nutrient, insect-pest, disease and weed management; On-farm inputs preparation methods and protocols, Studies in green manuring in-situ and green leaf manuring, Studies on different types of botanicals and animal urine and dung based non-aerated and aerated inputs for plant growth, nutrient, insect and pest and disease management; Weed management practices in natural farming; Techniques of Indigenous seed production- storage and marketing, Partial and complete nutrient and financial budgeting in natural farming; farming; Evaluation of ecosystem

services in natural farming (Crop, Field and System). Case studies and success stories in natural farming and chemical free traditional farming

Suggested readings

1. Ayachit, S.M. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri-History Foundation 4: 205.
2. Boeringa, R. (Eed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199 pp.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
4. Ecological Farming -The seven principles of a food system that has people at its heart. May 2015, Greenpeace.
5. Ecological Farming, The Seven principles of a food system that has people at its heart. May 2015, Greenpeace
6. FAO. 2018. The 10 elements of agro-ecology: guiding the transition to sustainable food and agricultural system.https://www.fao.org/3/i9037en/i9037en.pdf Agro ecosystem Analysis for Research and Development Gordon R. Conway.1985.
7. Fukuoka, M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp
8. Fukuoka, M. 1985. The Natural Way of Farming: The Theory and Practice of Green Philosophy. Japan Publications, Tokyo, 280 pp.
9. Hill S.B and Ott. P. (Eeds.). 1982. Basic Techniques in Ecological Farming Berkhauser Verlag, Basel, Germany, 366 pp.
10. Hill, S.B. and Ott, P. (Eeds.). 1982. Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
11. HLPE. 2019. Agroeeological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and nutrition of the Committee on World Food Security, Rome. https://fao.org/3/ea5602en/ea5602en.pdf.
12. INFRC. 1988. Guidelines for Nature Farming Techniques. Atami, Japan. 38 pp.
13. Khurana, A. and Kumar, V. 2020. State of Organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
14. Malhotra R. and S.D. Babaji. 2020. Sanskrit Non Translatable- The importance of Sanskritizing English. Amaryllis, New Delhi India.
15. Nalini, S. 1996. Vrikshayurveda (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telengana), India. 94pp.
16. Nalini, S. 1999. Krishi-Parashara (Agriculture by Parashara) by Parashara. Brig Sayeed Road, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
17. Nalini, S. 2011. Upavana Vinoda (Woodland Garden for Enjoyment) by Sarangdhara (13th century CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 64p
18. Natural Asset Farming: Creating Productive and Biodiverse Farms by David B. Lindenmayer, Suzannah M. Macbeth, et al. (2022)
19. Natural Farming Techniques: Farming without tilling by Prathapan Paramu (2021)
20. Plenty for All: Natural Farming A to Z Prayog Pariwar Methodology by Prof. Shripad A. Dabholkar and Prayog Pariwar Prayog Pariwar (2021)
21. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, Ottho Heldringstraat.
22. Shamasastry, R. 1915. Kautilya's Arthashastra.
23. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016)
24. U. K. Behera. 2013. A text Book of Farming System. Agrotech Publishing House, Udaipur.

Semester IV

VAC-221	Agricultural Informatics and Artificial Intelligence	2+1

Objective

i) To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
ii) To provide basic knowledge of computer with applications in agriculture
iii) To make the students familiar with agricultural-informatics, its components and applications in agriculture and Artificial intelligence

Theory
Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputsoutputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India. Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical
Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management. Use of MS-Word and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings
1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India. 5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.
6. Russell, Stuart, Artificial Intelligence: A Modern Approach, Pearson Edition 2013.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa.

HOR-221	Production Technology of Vegetables and Spices	1+1

Objectives
1. To educate about the different forms of classification of vegetables
2. To educate about the origin, area, climate, soil, improved varieties and cultivation practices of vegetables and spices

3. To educate about the physiological disorders of vegetables and spices

Theory
Importance of vegetables and spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of important vegetable and spices (tomato, okra, brinjal, chili, capsicum, cucumber, bitter gourd , bottle gourd, sweet potato, cassava and moringa, pumpkin, French bean, peas; cole crops such as cabbage, cauliflower, knol-khol; bulb crops such as onion, garlic; root crops such as carrot, radish, beetroot; tuber crops such as potato; leafy vegetables such as amaranth, palak, perennial vegetables, spice crops like turmeric, zinger, garlic, coriander, cumin, black pepper, cardamom, fenugreek, fennel, clove, nutmeg, cinnamon, curry leaf, tamarind and herbal spices).

Practical
Identification of vegetables and spice crops and their seeds. Description of varieties. Propagation methods - rapid multiplication techniques - seed collection and extraction. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables and spices. Fertilizers applications. Harvesting and post-harvest practices, Economics of vegetables and spices cultivation**,** visit to spice gardens.

Suggested readings
1. Olericulture, Fundamentals of Vegetable Production (Vol.1) by K.P. Singh, Anant Bahadur
2. Vegetable crops by J. Kabir, T.K. Bose, M.G. Som
3. Vegetable crops (Production technology, Vol II) by M.S. Fagaria, B.R. Choudhury, R.S. Dhaka

AECO-221	**Principles of Agricultural Economics and Farm Management**	**2+0**

Objectives
1. To aware the students about broad areas covered under agricultural Economics and farm management
2. To impart knowledge on judicious use of resources for optimum production

Theory
Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro- and macro-economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. Demand: meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumers equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. Laws of returns: Law of variable proportions and law of returns to scale. Cost: Cost concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. National income: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programs on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation. Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning. Forms of business organizations, international trade and balance of payments. GST and its implication on Indian economy. IKS perspective of Utility, Equity, Sustainability & Social Welfare (Sarve bhavantu sukhinah); Value systems & ethics in economics (artha, karma, dharma, moksha & ethical living). Economic Growth with intergenerational responsibility & harmony with nature; Framework for taxation, just wages, fair trade and market regulation in Arthasasthra & Thirukkural;

Traditional Indian agrarian societies and social justice (Gram Swaraj, Van Panchayats and Tank irrigation committees).

Suggested Readings

1. Johl, S.S. and T.R Kapur. 2009. Fundamentals of Farm Business Management. Kalyani Publishers
2. S. Subha Reddy, P. Raghu Ram, T.V. Neelakanta and I. Bhvani Devi .2004. Agricultural Economics. Oxford & IBH publishing Co. Pvt. Ltd

AGR-221	Crop Production Technology-II (*Rabi* Crops)	1+2

Objectives

1. To impart basic and fundamental knowledge on principles and practices of *rabi* crop production.
2. To impart knowledge and skill on scientific crop production and management.

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops. Cereals- wheat and barley. Pulses-chickpea, lentil, peas, *Rabi* redgram and rajmash. Oilseed- rapeseed & mustard, sunflower, safflower and linseed. Sugar crops- sugarcane and sugar beet. Medicinal and aromatic crops- Bacopa, Ashwagandha, Giloy mentha, lemongrass and citronella. Forage crops –berseem, lucerne and oat; potato, quinoa, tobacco. Indian knowledge system regarding *rabi* crop cultivation.

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. Indian knowledge system regarding *rabi* crop cultivation.

***Practical Crop Production-One (1) credit from practical of the course is allotted for Practical Crop Production of selected *rabi* crops covered under this course.**

Suggested Readings

1. B. Gurarajan, R. Balasubramanian and V. Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
2. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
4. Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICAR Publication.
5. S.R. Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
6. S.S. Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
7. Rajendra Prasad. 2002. Text Book of Field Crops Production, ICAR, New Delhi.
8. Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
9. Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi.
10. UAS, Bangalore. 2011. Package of Practice. UAS, Bengaluru.

AEG-221	Farm Machinery and Power	1+1

Objectives

To enable the students to understand the need of farm power, basic principles and parts of IC engine, different tillage, sowing, intercultural, plant protection equipment, working principles of threshers, harvesting of field and horticultural crops.

Theory

Status of Farm Power in India; Sources of Farm Power, I.C. engines, working principles of IC engines; comparison of two stroke and four stroke cycle engines, Study of different components of I.C. engine,

I.C. engine terminology and solved problems; Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor; Familiarization with Power transmission system : clutch; gear box, differential and final drive of a tractor; Tractor types; Cost analysis of tractor power and attached implement; Criteria for selection of tractor and machine implements. Familiarization with Primary and Secondary Tillage implement; Implement for hill agriculture; implement for intercultural operations; Familiarization with sowing and planting equipment; calibration of a seed drill and solved examples; Familiarization with Plant Protection equipment; Familiarization with harvesting and threshing equipment.

Practical
Study of different components of I.C. engine. To study air cleaning and cooling system of engine; Familiarization with clutch, transmission, differential and final drive of a tractor; Familiarization with lubrication and fuel supply system of engine; Familiarization with brake, steering, hydraulic control system of engine; Learning of tractor driving; Familiarization with operation of power tiller; Implements for hill agriculture; Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow; Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and trans planter; Familiarization with different types of sprayers and dusters; Familiarization with different inter-cultivation equipment; Familiarization with harvesting and threshing machinery; Calculation of power requirement for
different implements.

Suggested readings
1. `Jagdiswar Sahay – Elements of Agricultural Engineering
2. `Jain, S.C. and C.R. Rai-Farm Tractor and maintenance and repair. Standard Publishers, 1705-B, Naisarak. Delhi- 110006
3. `Ojha, T.P. and A.M. Michael, A.M. Principles of Agricultural Engineering. Vol.I. Jain brothers, 16/893, East Park Road, Karol Bagh, New Delhi -110005
4. `Surendra Singh- Farm machinery –Principles and applications, ICAR, New Delhi

AGR-222	Water Management	1+1

Objectives
1. To study the important properties of soil affecting water availability to crops and water requirement for optimum growth and development
2. To study different methods of irrigation and water management practices of field crops and drainage.

Theory
Irrigation: definition and objectives; Importance: Function of water for plant growth, water resources and irrigation development for different crops in India; Soil plant water relationships; Available and unavailable soil moisture, distribution of soil moisture, water budgeting, rooting characteristics, moisture extraction pattern, effect of moisture stress on crop growth. Methods of soil moisture estimation, evapotranspiration and crop water requirement; effective rainfall, different approaches of scheduling of irrigation; Methods of irrigation: surface and sub-surface, pressurized methods, viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water; Layout of different irrigation systems, Irrigation efficiency and water use efficiency, conjunctive use of water, irrigation water quality and its management. Water management of different crops (rice, wheat, maize, groundnut, rapeseed & mustard, chickpea sugarcane and potato); Layout of underground pipeline system, Irrigation automation, Artificial Intelligence and climate-based irrigation practices and its management. Pitcher irrigation (Kalsi or Matka irrigation) method.

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 by using water measuring devices viz., flumes, weirs, notches, orifices; 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; Visit to farmers' field and cost estimation of drip irrigation system; Demonstration of filter cleaning, fertigation, injection and flushing of laterals; layout for different methods of irrigation, Erection and operation of sprinkler irrigation

system; Measurement of emitter discharge rate, wetted diameter and calculation of emitter discharge variability; Visit to irrigation research centre/ station and visit to command area.

Suggested Readings

1. Rao, Y.P. and Bhaskar, S.R. Irrigation technology. Theory and practice. Agrotech publishing Academy, Udaipur.
2. Dilipkumar Mujmdar. Irrigation water management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
3. S.V. Patil &Rajakumar, G. R., Water Management in Agriculture and Horticultural Crops. Satish serial publishing House, Delhi.
4. Carr M. K. V. and Elias Fereres. Advances in Irrigation Agronomy. Cambridge University Press.
5. Michael, A.M. Irrigation Theory and practice. Vikas publishing house Pvt, Ltd.

SSC-221	Problematic Soils and their management	1+1

Objectives

1. To acquaint the students about various problem soils like degraded soils, acid soils, saline soils, alkali soils, eroded soils, submerged soils, polluted soils. Also to impart knowledge about remote sensing, GIS, Multipurpose tree and Land capability classification
2. To give hands on training about estimation of various soil and water quality parameters associated with problem soils.
3. To focus on ancient technologies in managing problematic soils.

Theory

Soil quality and health, Distribution of Waste land and problem soils in India, Categorization of Problem soils based on properties. Reclamation and management of Acid soils, Saline, Sodic soils, Acid Sulphate soils, Eroded and Compacted soils, polluted soils. Contaminated soils (Pesticide contamination, Heavy metal contamination), Mined soils (Coal mined, Oil mined), Management of Riverine soils, Waterlogged soils, Irrigation water – quality and standards, utilization of saline water in agriculture. Use of Remote sensing and GIS in diagnosis and management of problem soils. Irrigation and water quality. Multipurpose tree (MPT) species, bio remediation through MPTs of soils, land capability and classification, land suitability classification.

Management of problematic soils by use of organic amendments, crop rotation, marl, shells, guano deposits, ashes etc in managing physically and chemically degraded soils. Native agroforestry practices featuring multipurpose tree species (MPTs) for enhancing soil fertility.

Practical

Determination of pHs and EC of saturation extract of problematic soil. Determination of redox potential in soil, Estimation of water soluble and exchangeable cations in soil and computation of SAR and ESP and characterization of problematic soil. Determination of Gypsum requirement of alkali / sodic soil. Determination of lime requirement of acidic soil. Determination of Quality of irrigation water (pH, EC, Ca, Mg, Na, CO3, HCO3, Cl, SAR and RSC), Determination of nitrate (NO3-) from irrigation water, Determination of dissolved oxygen and free carbon dioxide levels in water samples. Field-level assessment of traditional amendments (e.g., cow dung ash, lime). Field-level assessment of native trees in improving soil fertility.

Suggested readings

1. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). Saline Alkali soils of India, ICAR, AGROBIOS (India).
2. Brady Nyle C and Ray R Well., 2014. Nature and properties of soils. Pearson Education Inc., New D Delhi.
3. Cirsan J. Paul., 1985. Principles of Remote Sensing. Longman, New York
4. Indian Society of Soil Science., 2002. Fundamentals of Soil Science. IARI, New Delhi.
5. Osman, Khan Towhid., 2018., Management of Soil Problems. Springer publication
6. Srivastava, V. C., 2002. Management of Problem Soils -Principles and Practices New Delhi

GPB-221	Basics of Plant Breeding	2+1

Objectives

To acquaint students with different techniques ranging from simply selecting plants with desirable characteristics for propagation, to more complex molecular approaches for breeding new varieties that are higher yielding and resistant to biotic and abiotic stresses, while integrating Indian Knowledge Systems (IKS), traditional practices documented in Vṛkṣāyurveda, Kṛṣi-Parāśara, and Arthashāstra, and the role of cultural conservation in ensuring food security.

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects, including contributions from Indian Knowledge Systems (IKS) documented in *Vṛkṣāyurveda*, *Kṛṣi-Parāśara*, *Arthashāstra* and *Atharvaveda*, with references to hybridization (*sankara*). Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male-sterility—genetic consequences, cultivar options. Plant genetic resources, their utilization and conservation, traditional practices of seed selection, storage**,** sacred groves (*devara kadu*), and conservation of germplasm through rituals, festivals like *Nabanna*, and use of specific plant types in cultural ceremonies (*navadhanya*). Domestication, acclimatization and introduction. Centres of origin/diversity, components of genetic variation, historical perspectives of crop domestication. Heritability and genetic advance. Pre-breeding and Universal Plant Breeders equation. Genetic basis and breeding methods in self-pollinated crops—mass and pure line selection, hybridization techniques and handling of segregating populations, and farmer-led selection. Multiline concept, concepts of population genetics and Hardy-Weinberg Law. Genetic basis and methods of breeding cross-pollinated crops, modes of selection. Population improvement schemes—Ear to Row method, Modified Ear to Row, recurrent selection schemes. Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties. Breeding methods in asexually propagated crops, clonal selection and hybridization, indigenous clonal propagation (*ankur vistar*). Wide hybridization and pre-breeding. Polyploidy in relation to plant breeding, mutation breeding—methods and uses. Breeding for important biotic and abiotic stresses, including IKS approaches like varietal blends. Participatory plant breeding integrating community knowledge. Variety release and notification. Intellectual Property Rights, Patenting, Plant Breeders' and Farmers' Rights, and protection of Indian knowledge systems.

Practical

Plant Breeder's kit, Study of germplasm of various crops, Study of floral structures of self-pollinated and cross-pollinated crops, Emasculation and hybridization techniques in self- and cross-pollinated crops, Consequences of inbreeding on genetic structure of resulting populations, Study of male sterility system, Handling of segregating populations, Methods of calculating mean, range, variance, standard deviation, heritability, Designs used in plant breeding experiments, analysis of Randomized Block Design, To work out the mode of pollination in a given crop and extent of natural out-crossing, Prediction of performance of double cross hybrids, Maintenance of breeding records and data collection, Screening tests for biotic and abiotic stresses, Collection and documentation of scriptural references on breeding practices and the use of specific plant types in rituals and cultural traditions.

Suggested Readings

1. *Principles of Plant Breeding* (1st & 2nd Edition) by R.W. Allard
2. *Plant Breeding: Principles & Practices* by J.R. Sharma
3. *Plant Breeding* by B.D. Singh
4. *Principles and Procedures of Plant Breeding – Biotechnical and Conventional Approaches* by G.S. Chahal and S.S. Gosal
5. *Principles of Plant Genetics and Breeding* by George Acquaah
6. *Vrikshayurveda* (English Translation)
7. *Krishi-Parashara* (translated editions)
8. *Arthashastra of Kautilya* (sections on agriculture and crop management)
9. *Traditional Knowledge Digital Library (TKDL)* – Government of India resources on traditional agricultural practices

Semester V

MDC-311	Agriculture Marketing and Trade	2+1

Objective

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

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 agricommodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; 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 and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in 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; WTO; Agreement on Agriculture (AoA), and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context. Core Principles of IKS in Agricultural Marketing & Trade; History of rural trade in India: Traditional local markets (Haats, Shandies and Melas); indigenous marketing institutions (Guilds) & market intermediaries; Indigenous Value Addition and Processing (Sun drying); Traditional Storage and Distribution Systems (Grain Banks, Seed Banks, Temple Granaries); Community and Cooperative Trade Models; Ethical and Cultural Dimensions of risk management, pricing & trade (crop sharing); Role of festivals in trade cycles.

Practical

Plotting and study of demand and supply 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. Suggested

Readings

1. Acharya, S.S. and Agarwal, N.L. 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna, S.S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N. 2002. Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong. 2005. Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Singh, Joginder. 2006. Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I. 2003. Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.

8. Pandey, Mukesh and Tewari, Deepali. 2004. Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R. 2005. Export Management, Laxmi Narain Agarwal, Agra.

AGR-311	Introduction to Agro-meteorology	1+1

Objectives

1. To introduce the students to the concept of weather and climate and underlying physical processes occurring in relation to plant and atmosphere and traditional Indian agricultural practices related to weather and climate
2. To impart the theoretical and practical knowledge of instruments/equipment used for measurement of different weather variables in an agrometeorological observatory
3. To study the meteorological aspects of climate change in agriculture and allied activities

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, long wave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Application of Thermal time concept and Crop/Pest weather calendar; Energy balance of earth; Atmospheric humidity, concept ofsaturation, vapour pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture; Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave; Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national agriculture. Traditional Indian knowledge in Agrometeorology - Exploring reference to weather and climate in ancient Indian texts (Vedas, Puranas, *etc*.) and their relevance to agriculture; Studying traditional methods of weather forecasting based on observation of celestial bodies, animal behavoiur and natural phenomena; Exploring the role of traditional crop varieties that are well-suited to specific climatic conditions.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording, Measurement of total, shortwave and long wave radiation, and its estimation using Planck's intensity law, Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS; Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis, Measurement of soil temperature and computation of soil heat flux, Determination of vapor pressure and relative humidity, Determination of dew point temperature, Measurement of atmospheric pressure and analysis of atmospheric conditions, Measurement of wind speed and wind direction, preparation of windrose, Measurement, tabulation and analysis of rain, Measurement of open pan evaporation and evapotranspiration, Computation of PET and AET, Use of synoptic charts, weather reports, weather forecasting-types and methods, crop weather calendar.

Suggested Readings

1. Agricultural Meteorology by G.S.L.H.V. Prasado Rao
2. Fundamentals of Agrometeorology and Climate Change by G. S. Mahi and P. K. Kingra
3. Introduction to Agrometeorology and Climate Change by Alok Kumar Patra
4. Introduction to Agrometeorology by H. S. Mavi
5. Text Book of Agricultural Meteorology by M. C.Varshneya and P.B. Pillai

CPH-311	Fundamentals of Crop Physiology	2+1

Objectives

To explain about the basic physiological process of plant viz. plant cell and water relations, mineral nutrition, carbon metabolism, reproductive physiology and plant growth and development

Theory

Definitions of plant physiology and crop physiology; Importance of crop physiology; Relationship of crop physiology with other branches of crop science; Diffusion and osmosis; Physiological roles of water to crop plants; Definition of water potential and components of water potential; Water absorption by plants: Concept of active and passive absorption; Water loss by plants: Types of water loss: transpiration, stomatal physiology and guttation; Water use efficiency; Essential and beneficial elements; Passive and active transport of mineral element; Functions of essential elements; Criteria of essentiality of nutrients; Correction measures for nutrient deficiency symptoms; Foliar nutrition and root feeding – significance; Aeroponics Imbibition; Field capacity, permanent wilting point and available soil moisture; Apoplast, symplast and transmembrane, Ascent of sap – theories and mechanism; Soil-plant-atmospheric continuum. Significance of transpiration. Stomatal opening and closing mechanisms. Definition of Cavitation and embolism. Antitranspirants - types and examples. Hydroponics and sand culture. Overview of plant cell - organelle and their functions. Brief outline of: Photosynthetic apparatus, pigment system, quantum requirement and quantum yield; Structure of chloroplast, Examples of different photosynthetic pigments (chlorophyll, carotenoids, phycobilins etc.), Difference between chlorophyll a and chlorophyll b, Structure of chlorophyll a and chlorophyll b, Short discussion on quantum requirement and quantum yield, Red drop and Emerson enhancement effect, Pigment system I and II. Introduction to light reaction of photosynthesis, Light absorption by photosynthetic pigments and transfer of energy. Source of O2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers; Introduction to C3, C4 and CAM pathways: Calvin Cycle, Hatch and Slack Cycle, CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C4 plant: Productivity of C4 plant, CAM: an adaptive mechanism); Factors affecting photosynthesis (light, temperature, CO2, O2 etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb Cycle and ETC, Factors affecting respiration (O2, temperature, CO2 etc.). Terminologies / Definitions: Growth, Development and Differentiation. Measurement of plant growth (fresh weight, dry weight, linear dimension, area etc.). Introduction to CGR, RGR, NAR etc. Photoperiodism: Photoperiodic Classification of plants: Short Day Plant, Long Day Plant, Day Neutral plant etc. Introduction to Photoperiodic induction site of photo-inductive perception, Role of Phytochrome Introduction to Vernalization (What is vernalization, devernalization etc.), Meaning, classification (seasonal, sequential etc), relation with abscission. Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR), Plant growth inhibitor. Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 –D, GAs, Kinetin etc).

Practical

Study on structure and distribution of stomata; Demonstration of imbibition, osmosis, plasmolysis, estimation of water potential, relative water content; Tissue test for mineral nutrients, identification of nutrient deficiency and toxicity symptoms in plant; Identification of nutrients by hydroponics; Estimation of photosynthetic pigments, rate of photosynthesis, respiration and transpiration; Plant growth analysis; Study on senescence and abscission, hormonal regulation of senescence; Demonstration of the effects of different PGRs on plants, Leaf anatomy of C3 and C4 plants.

Learning Outcomes

1. Students will understand about different aspects of crop physiological processes and their applications in agricultural research
2. Students will understand the physiological basis of yield variation in crop plants
3. The knowledge in crop physiology acquired by the students will be useful for achieving higher productivity of crops

AEN-321	Pest Management in Crops and Stored Grains	2+1

Objectives

a. To get acquainted with Diagnosis and management of major insect and non- insect pests of crops in field and storage
b. To get acquainted with different types of insecticides, their Identification, toxicity and formulations
c. To get acquainted with modern day pest management using Artificial Intelligence.

Theory

Linkage of ancient Indian knowledge System (IKS) on insect-pest management and its refinement. General description on nature and type of damage by different arthropod pests; Scientific name, order, family, host range, distribution, biology and bionomics; Nature of damage and management of major insect pests of various field crops, vegetable crops, fruit crops, plantation crops, ornamental crops, spices and condiments. Structural entomology and important household pests, their nature of damage and management. Factors affecting loss of stored grains. Insect pests, mites, rodents, birds and microorganisms associated with stored grains and their management. Storage structures and methods of grain storage and fundamental principles of stored grains management. Management of non insect pest of mites, snails and slugs, Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides, Biorational pesticides including insect repellents, antifeedants, Use of drones and AI in pest management.

Practical
Field visit, identification of major insect pests and their damage symptoms. Collection and preservation of major insect pests; collection of damage samples, their identification and herbarium preparation. Methods of monitoring of pest incidence in situ. Management strategies of insect pests of different crops. Study on structural entomology and household pests. Storage structures and methods of grain storage. Spraying techniques for selected field and horticultural crops. Vertebrate pest management, Mass multiplication of NPV and entomopathogenic nematodes.

Suggested readings

1. A Textbook of Insect Pest and Disease Management, 2021. Somnath Sen, and Mohd. Sameer, S. Kataria & Sons publish.
2. Agricultural Pests of India and South east Asia, A.S. Athwal, Kalyani Publishers.
3. A Textbook of Applied Entomology, K.P. Srivastava and G. S. Dhaliwal, Kalyani Publish.
4. Essentials of Pest Management: Key Information on Pest Identification and its Management, 2022. Prakash Rambhat Thalya and Ravi Chandra
5. Integrated pest Management Concept and Approaches- G.S. Dhaliwal and Ramesh Arora
6. Pest Management: Methods, Applications and Challenges, Tarique Hassan Askary, Agriculture, Agriculture Issues and policies, Books, Nova, Pest Control, Science and Technology,2022

PPC-311	Diseases of Field & Horticultural Crops & their management	2+1

Objectives
1. To study the symptoms produced on the host
2. To study the etiology of the diseases
3. To know about the disease cycle of the pathogens during pathogenesis
4. To study the epidemiological factors responsible for disease development
5. To study the management techniques for curbing the major diseases of field and horticultural crops

Theory
Symptoms, etiology, disease cycle, epidemiology and management of plant diseases through available indigenous knowledge of plant protection. of the following field and horticultural crops: Field crops- Rice (blast, brown spot, sheath blight, false smut, bacterial leaf blight, bacterial leaf streak, tungro, khaira); Wheat (rusts, loose smut, Karnal bunt); Maize (banded leaf and sheath blight, southern and northern blight, downy mildew); Sorghum (smuts, grain mold, anthracnose); Bajra (downy mildew, ergot) and Finger millet (blast, leaf spot); Groundnut (early and late leaf spots, rust, wilt); Soybean (rhizoctonia blight, bacterial spot, seed and seedling rot, mosaic); Grams (Ascochyta blight, wilt, grey mold); Pea (downy mildew, powdery mildew, rust); Black gram and Green gram (web blight, Cercospora leaf spot, anthracnose, yellow mosaic); Sugarcane (red rot, smut, grassy shoot, ratoon stunting, PokahBoeng); Mustard (Alternaria blight, white rust, downy mildew, sclerotinia stem rot) and Sunflower (sclerotinia stem rot, Alternaria blight); Cotton (anthracnose, vascular wilts, black arm). Horticultural crops: Citrus (canker, gummosis) and Guava (wilt, anthracnose); Banana (sigatoka, Panama wilt, bacterial wilt, bunchy top); Papaya (foot rot, leaf curl, mosaic) and Pomegranate (bacterial blight); Apple (scab, powdery mildew, fire blight, crown gall) and Peach (leaf curl); Grapevine (downy mildew, powdery mildew, anthracnose) and Strawberry (leaf spot); Coconut (bud rot, Ganoderma wilt), Tea (blister blight) and Coffee (rust); Mango (anthracnose, malformation, bacterial blight, powdery mildew); Potato (early and late blight, black scurf, leaf roll, mosaic) and Tomato (damping off, wilt, early and late blight, leaf curl, mosaic); Brinjal (phomopsis blight and fruit rot, sclerotinia blight) and Chilli (anthracnose and fruit rot, wilt, leaf curl); Cucurbits (powdery and

downy mildew, wilts) and Cruciferous vegetables (Alternaria leaf spot, black rot, cauliflower mosaic); Beans (anthracnose, bacterial blight) and Okra (yellow vein mosaic); Ginger (soft rot), Turmeric (leaf Spot) and Coriander (stem gall); Rose (dieback, powdery mildew, black leaf spot) and Marigold (botrytis blight, leaf spots).

Practical
To study the symptoms of different diseases of field and horticultural crops: Blast and brown spot of rice, sheath blight and bacterial leaf blight of rice, downy mildew and powdery of cucurbits, rhizoctonia and Cercospora leaf spot of green gram/black gram, Alternaria blight and downy mildew of mustard, early blight of late blight of potato and tomato, Phomopsis blight of brinjal, powdery mildew and rust of pea, stem gall of coriander, anthracnose and fruit rot of chilli, taphrina leaf spot of turmeric, red rot of sugarcane, acquaintance with fungicides, antibiotics and biopesticides and their use in management of diseases of horticultural crops. Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory.
Field visit for the diagnosis of field problems, Collection and preservation of plant diseased specimens for herbarium.

Suggested Readings
1. Integrated Plant Disease Management By R.C. Sharma
2. Plant Diseases By R.S. Singh
3. Plant Disease Management: Principles and Practices By Hriday Chaube
4. Plant Pathology By G.N. Agrios

GPB-311	Crop Improvement (*Kharif* Crops)-I	1+1

Objectives

1. To provide knowledge about Self-pollinated and cross pollinated Kharif crops
2. To learn about origin and distribution of Kharif crops
3. To design breeding objectives of major kharif crops
4. To impart information using Indian knowledge System and modern techniques on different crop varieties for Kharif season

Theory:
Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops of kharif season; Plant genetic resources, its utilization and On-farm and off-farm conservation strategies, Role of farmer-managed seed banks and community seed networks. 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, traditional and modern methods of abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in maize, rice, sorghum, pearl millet and pigeopea etc. Ideotype concept, Development of climate-resilient crop varieties using traditional knowledge and modern techniques for future.
Practical: Botany of crops, Floral biology, emasculation and hybridization techniques in different crop species, viz. rice, jute, maize, sorghum, pearl millet, ragi, pigeopea, urdbean, mungbean, soybean, groundnut, sesame, castor, cotton, cowpea, tabacco, brinjal, okra and cucurbitaceous crops. Maintenance breeding of different kharif crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seed production in kharif crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops. Case studies of IKS-based seed production in different kharif crops.
Suggested Readings
1. Breeding field crops -I by V.L. Chopra
2. Genetic improvement of field crops by C.B. Singh and D. Khare
3. Genetics and Breeding of Pulse crops by D.P. Singh
4. Vegetable breeding – Principles and Practices by Hari Har Ram
5. Breeding field crops by D.A. Sleper and J.M. Poehlman
6. Plant Breeding –theory and practice by S.K. Gupta

7. Breeding Asian field crops by J.M. Poehlman and D.N. Barthakur
8. Practical manuals on Crop Improvement I (Kharif crops) by Rajendra Kumar Yadav

AGR-312	Weed Management	1+1

Objectives
1. To teach students about principles of weed science
2. To impart practical knowledge of weed management in field and horticultural crops

Theory
Introduction to weeds, characteristics of weeds, their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds, crop-weed completion and factors affecting competition. Studies on weed seedbank, weed shifts. Concepts of weed management: physical, cultural, chemical and biological; principles and methods, integrated weed management. Implements for weed control, robotic weed control, weed management in organic/natural farming. Herbicide classification and properties of important herbicides, concept of adjuvants, surfactants, herbicide formulation and their use, Nano herbicides, precision weed management; Mode of action of herbicides and selectivity phenomenon. Concept of herbicide mixture and utility in agriculture, Herbicide compatibility with agro-chemicals and their application, Herbicide resistance and its management. Weed management in different field and horticultural crops; aquatic weed management, weed management in cropping systems. Exploring the use of medicinal plants and herbs for weed control as described in Ayurvedic texts like Charaka Samhita and Sushruta Samhita; Studying the traditional uses of weeds for various purposes (Ethnobotany of weeds) and understanding their cultural significance and the role of weeds in traditional farming practices including rituals, beliefs and folklore from an IKS perspective.

Practical
Techniques of weed preservation, weed identification and losses caused by weeds. Biology of important weeds. Study weeds in different situations, Study of herbicide formulations and mixture of herbicide. Study methods of herbicide application, Herbicide application equipment- their parts, use, maintenance and calibration. Weed control implements, Calculation of herbicide doses and requirement, weed control efficiency and weed index, Phytotoxicity of herbicides, Weed management in fallow lands, Management of problem and parasitic weeds.

Suggested Readings

1. Crafts, A.S. and Robbins, W.W. 1973. Weed Control. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Gupta, O.P. 1984. Scientific Weed Management. Today and Tomorrow Printers and Publishers, New Delhi.
3. Gupta, O.P. 2015. Modern Weed Management. Agro Bios (India), Jodhpur.
4. Naidu, V.S.G.R. Handbook of Weed Identification. Directorate of Weed Research, Jabalpur.
5. Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G. 2015. Weed management of Horticultural Crops. Agrobios (India), Jodhpur.
6. Ramamoorthy, K. and Subbian, P. Predominant Weed flora in hill –ecosystems. Agrobios (India), Jodhpur.
7. Rao, V.S. 2000. Principles of Weed Science. Oxford & IBH Publishing Co., New Delhi.
8. Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. All About Weed Control. Kalyani Publishers, Ludhiana.
9. Tadulingam, C. and Venkatnarayana, D. 1955. A Handbook of Some South Indian Weeds. Government Press, Madras.
10. Thakur, C. 1977. Weed Science. Metropolitan Book Co. Pvt. Ltd., New Delhi.

HOR-311	Ornamental Crops, MAPs and Landscaping	1+1

Objectives
1. To educate in detail about origin, area, climate, soil, improved varieties production technology of flowers and MAPs
2. To educate about concept, designing principles and components of landscaping
3. To educate about the physiological disorders of commercial flowers
4. To educate about the post-harvest management and value addition in flower crops and MAP

Theory

Importance and scope of medicinal and aromatic plants. Production technology of medicinal plants like medicinal solanum, medicinal yam, periwinkle, aloe, ashwagandha, costus, isabgol, coleus, glory lily etc. Production technology of aromatic plants like lemongrass, citronella, vetiver, palmarosa, mint, ocimum, geranium etc., Importance and scope of ornamental crops and landscaping; Principles of landscaping; Landscape uses of trees, shrubs and climbers, Brief concept of Home landscaping, Carpet bedding, Topiary, Bonsai, Lawn, flower arrangement, Herbaceous Border, Hedge, Edge etc.; Production technology of important cut flowers like rose, gerbera and orchids; Production technology of gladiolus, tuberose, lilium, chrysanthemum and carnation; Package of practices for loose flowers like marigold and jasmine under open conditions; Processing and value addition imp ornamental crops; Processing and value addition of MAPs produce. Ayurvedic plant classification like *Rasa*, *Guna*, *Virya*, *Vipaka*, and *Prabhava* for understanding medicinal properties; **E**thnobotanical knowledge including tribal and folk medicine practices using local herbs (e.g., tulsi, ashwagandha, brahmi); **T**raditional cultivation practices like organic and lunar based sowing, intercropping with synergistic herbs; Sacred groves and conservation-traditional biodiversity conservation systems (e.g., *Devrai*, *Panchavati*) preserving rare medicinal species; Herbal formulations like preparation methods of traditional medicines like *kadha*, *choorna*, *asava*, and *arista* etc.; Aromatic uses in rituals – like incense, oils, and healing ceremonies; T**r**aditional harvesting techniques **–** Include auspicious timing and methods for maximizing potency.

Practical

Identification MAPs and Ornamental plants (trees, shrubs, climbers, seasonal flower and house plants). Propagation of MAP, Bed preparation and planting of MAP; Nursery bed preparation and sowing of seasonal flower seeds; Propagation of ornamental plants by terminal/herbaceous cuttings; Propagation of Anthurium and orchids; Propagation of bougainvillea; Planting of gerbera suckers; Gladiolus corms; Establishment and maintenance of lawn; Preparation of flower preservatives and their use in extending the vase life of cut flowers; Training and pruning of ornamental plants and raising of hedge and edge; Planning and layout of garden.

Suggested readings

1. Floriculture in India by G.S. Randhawa and Mukopadhyay
2. Introduction to spices, plantation crops, medicinal and aromatic plants by N. Kumar, Abdul Khadder, P. Rangaswamy, I. Irulappam
3. Textbook of floriculture and landscaping by Anil K. Singh and Anjana Sisodia
4. Commercial flowers (Vol 1 and 2) by T.K. Bose.

AGR-313	**Introductory Agro forestry**	**1+1**

Objectives

1. To study Agro forestry as an alternate system of land use
2. To study different types of Agro forestry for soil and water conservation.
3. To study the characteristics of Agro forestry in terms its potential for soil moisture conservation practices

Theory

Agro-forestry: Definition and scope of Agroforestry system, Type of Agroforestry system, potential of Agroforestry in India, Prevailing agroforestry system in India; MPTS- definition, role of MPTS in agroforestry system, its selection for different agroforestry system, MPTS of India, Ecological aspects of Agroforestry system, tree -crop interaction – competition, nutrient recycling; Traditional Agroforestry as a viable choice to conserve Agro biodiversity of India. Management of Agro-forestry system; Role of agroforestry in soil and water conservation; windbreak; Shelterbelt–definition, objectives.; Socio-economic aspects of Agroforestry system; Design and Diagnostic study of agroforetry system; Silviculture: Definition and scope, Propagation of tree species, Regeneration by seed, coppice, root suckers, Transplanting, stump, branch cutting, rhizomes; Nursery bed preparation and management; Cultural practices for bare root and seedling, fieldhandling of nursery stock; Management of tree species; Silviculture of important tree species, choice of species- site factors, root, crown and bole characteristics, phenology, nutritional and water requirement, ground operation, tending, harvesting utility etc. Horticulture and foragecrops-based agroforestry models developed by ICAR-IGFRI; Agroforestry models developed by Indian council of Forestry Research and Education.

Practical
Identification of tree species in agro-forestry, Study of tree growth measurement, Study of environmental parameters affecting AF System, Plant propagation methods, Pre-sowing seed treatment, Preparation of nursery bed exercise, practicing propagation techniques for trees, Afforestation method, practical training, pruning, coppicing, pollarding etc. Planting pattern and designs for plantation, natural and artificial regeneration, Design and diagnostic survey of agroforestry system, Evaluation of agro-forestry system in different agro climatic zones, Exposure Visit to prevailing agroforestry systems of the state and related important institutions, Virtual visit of agroforestry models developed by ICAR-IGFRI, ICFRE.

Suggested readings

1. Nair, P.K. R. 1993. An Introduction to Agroforestry, Kluar Academic Publisher
2. Chundawat D. S. and S.K. Gautham. 2017. Textbook of Agroforestry. Oxford & IBH Publishing, (ISBN: 9788120408326)
3. Parthiban, K. T, N. Krishnakumar and M. Karthick. 2018. Introduction to Forestry, Scientific Publisher, Jodhpur. 350p
4. Divya M. P. and K. T. Parthiban. 2005. A Textbook on Social Forestry and Agroforestry. Satish Serial Publishing, New Delhi (ISBN: 9384988952).

Semester VI

GPB-321	Fundamentals of Agricultural Biotechnology	2+1

Objectives
To familiarize students with the fundamental principles of biotechnology, various developments and applications, including early Indian knowledge systems, philosophical concepts of plant vitality, traditional practices for preserving plant diversity, and the pioneering experiments of Sir Jagadish Chandra Bose.

Theory
Introduction to Plant Tissue Culture and Genetic Engineering: History and early practices described in *Vṛkṣāyurveda, Krishi-Parāśara, Arthashastra*, and *Atharvaveda*, philosophical concepts by Great Indian Sages regarding plant vitality (*prāṇa*) and responsiveness, and the experimental work of Sir Jagadish Chandra Bose demonstrating electrical signaling and growth responses foundational to modern plant physiology; Cellular totipotency and cytodifferentiation; Callus culture, single-cell and suspension culture and their applications; Organogenesis and somatic embryogenesis; Somaclonal variation and its use in crop improvement; Embryo rescue technique and its significance in hybrid development; In vitro fertilization, ovule culture and its significance in hybrid development; Protoplast isolation, culture and regeneration; Somatic hybridization (somatic hybrids and cybrids) and its application in crop improvement; Anther and pollen culture for haploid production; Development of disease-free (virus-free) plants through apical meristem culture, including traditional practices such as selection of *rog rahita bīja (disease-free seed)*, and solar sanitation; Micropropagation techniques for generating quality planting material; Synthetic seeds and their applications; National certification and quality management of tissue-cultured plants; secondary metabolite production; in vitro germplasm conservation and cultural practices of preserving plant diversity through sacred groves, and community seed banks.

Introduction to Molecular Biology: DNA structure and function; DNA replication, transcription and translation; RNA types and functions; Structure of prokaryotic and eukaryotic genes; Central dogma of life—DNA replication, transcription, genetic code, translation and protein synthesis; Lac Operon concept; Nucleic acid hybridization; Polymerase chain reaction; DNA sequencing—Sanger method; PCR and its applications, with reference to historical Indian contributions to understanding plant and biological processes.

Introduction to Recombinant DNA Technology: DNA-modifying enzymes and vectors; Plant genetic transformation—physical (gene gun), chemical (PEG-mediated) and Agrobacterium-mediated gene transfer methods; Transgenics and their importance in crop improvement, with successful examples; biosafety and ethical considerations, including traditional perspectives on biodiversity protection.

Introduction to various molecular markers: RFLP, RAPD, SSR, SNP etc.; Marker-assisted breeding in crop improvement and integration with traditional selection and conservation practices.

Practical
Introduction to Plant Tissue Culture Laboratory; Good Laboratory Practices; Media Preparation and sterilization; Glassware sterilization; Micropropagation; Callus induction and culture; Anther culture; Apical meristem culture; Preparation of synthetic seeds; Isolation of plasmid DNA; Quantification of DNA; Agarose Gel Electrophoresis and visualization of plasmid DNA; Restriction digestion of plasmid DNA and agarose gel electrophoresis; Isolation of Plant genomic DNA; PCR amplification of DNA; Gel electrophoresis of amplified DNA; Visit to tissue culture units /biotech labs. Collection and documentation of scriptural references on biotechnological practices and the use of specific plants, plant-derived substances, or foods in rituals and cultural traditions.

Suggested readings
1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani
3. Christou P and Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
4. Lewin B. 2008. Gene IX. Peterson Publications/ Panima. W.H. Freeman & Co.
5. Primrose SB. 2001. Molecular Biotechnology. Panima.

AST-311	Basic and Applied Agril Statistics	2+1

Objectives

This course is meant to expose the students to various concepts of descriptive statistical methods and statistical inferential procedures which would help them in understanding the concepts involved in data collection, its presentation, analysis and interpretation. This course will also provide them with the understanding of the early development of statistics in ancient India.

Theory

Statistics as a method of learning from experience and decision making under uncertainty were practiced from the beginning of human civilization. Here the ancient foundations of statistical practices in Indian civilization with a focus on agriculture, population and economic census in villages and towns will be explored. Data collection systems found in ancient texts like Vyasa's Mahabarata, Kautilya's (321-296 BC) Arthashastra, Abul Fazal's Ain-i-Akbari (1596-1597 AD) and others which documented methods of estimation, land classification and resource planning will be discussed. A brief discussion will be made on the first use of arithmetic mean as the best representative value for a set of observations in statistical sense which can be found in ancient India's texts (Brahamagupta, 628 AD). How population data and vital statistics were maintained in ancient India as seen in Manusmriti and the administrative practices of the Chola dynasty will also be explained.

Introduction to Statistics and its Applications in Agriculture. Types of Data. Scales of measurements of Data. Summarization of Data. Classification of Data. Frequency Distribution. Methods of Classification. Definition of Grouped and Ungrouped Data. Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points. Types of Frequency Distribution. Diagrammatic Presentation of Data. Bar Diagrams – Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram. Graphical Presentation of Data – Histogram, Frequency Polygon and Ogives, Stem and leaf plot. Measures of Central Tendency. Requisites for an Ideal Measure of Central Tendency. Different Types of Measure. Arithmetic Mean– Definition, Properties, Merits, Demerits and Uses. A.M. (examples) for Grouped and Ungrouped Data. Outlier observations. Trimmed Mean. Step-deviation Method. Weighted Mean. Definition of Geometric Mean and Harmonic Mean. Relationship between A.M., G.M. and H.M. Median Definition, Merits, Demerits and Uses. Graphical Location of Median. Mode-Definition, Merits, Demerits and Uses. Graphical Location of Mode. Relationship between Mean, Median and Mode.

Measures of Dispersion. Characteristics for an Ideal Measure of Dispersion. Different Types of Measures of Dispersions. Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation. Standard Deviation- Definition, Properties. S.D. and Variance for Grouped and Ungrouped Data. Variance of Combined Series. Co-efficient of Dispersions. Co-efficient of Variation. Box plot and five-number summary statistics.

Measures of Skewness and Kurtosis. Definition of Symmetrical Distribution. Definition of Skewness, Measures of Skewness. Definition of Kurtosis. Measure of Kurtosis. Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Correlation and Regression. Definition of Correlation. Scatter Diagram. Karl Pearson's Coefficient of Correlation. Types of Correlation Coefficient. Properties of Correlation Coefficient. Definition of Linear Regression. Regression Equations. Regression Coefficients. Properties of Regression Coefficients.

Introduction to Probability. Basic Terminology. Classical Probability-Definition and Limitations. Empirical Probability- Definition and Limitations. Axiomatic Probability. Addition and Multiplication Theorem (without proof). Conditional Probability. Independent Events. Simple Problems based on Probability.

Definition of Random Variable. Discrete and Continuous Random Variable. Introduction of Binomial and Poisson distributions with basic properties. Normal Distribution- Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve.

Sampling Theory. Introduction. Definition of Population, Sample, Parameter and Statistic. Sampling Vs Complete Enumeration. Sampling Methods. Simple Random Sampling with Replacement and without Replacement. Use of Random Number Table.

Tests of Significance. Null and Alternative Hypothesis. Type I and Type II Errors. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample (Z and t), Two Sample independent and dependent (Z and t) test with Examples. F-test for Variance.

ANOVA and Experimental Designs. Assumptions of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD).

Practical

Diagrammatic and Graphical representation of data. Calculation of A.M., Median and Mode (Ungrouped and Grouped data). Calculation of S.D. and C.V. (Ungrouped and Grouped data). Correlation and Regression analysis. Application of Z and t-test (one sample, two sample independent and dependent). Analysis of variance one-way classification. CRD. Selection of random sample using simple random sampling.

Learning Outcome:

It is expected that the students will be equipped with basic statistical tools used for analyzing data sets and will be able to draw valid conclusion supported by statistical philosophy.

Suggested readings

1) Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
2) Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers.
3) Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
4) Basic Statistics by B. L. Agarwal, New Age International Publishers.
5) Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
6) Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.
7) Probability and Statistical Inference by D. Bhattacharya and S. Roychowdhury, 3rd ed. U.N. Dhur and Sons
8) Statistics: Theory and Practice by D. Bhattacharya and S. Roychowdhury, 4th ed. U.N. Dhur and Sons

GPB-322	Crop Improvement (*Rabi* crops)-II	1+1

Objectives:

1. To provide knowledge about self-pollinated and cross-pollinated rabi crops
2. To learn about origin and distribution of rabi crops
3. To design breeding objectives of major rabi crops

4. To impart information using traditional knowledge and modern techniques on different crop varieties for rabi season

Theory
Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops; Plant genetic resources, its utilization and On-farm and off-farm conservation strategies, Role of farmer-managed seed banks and community seed networks, 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, traditional and modern methods of abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in wheat, oat, chickpea, rapeseed and mustard etc. Ideotype concept, climate resilient crop varieties using traditional knowledge and modern techniques for future.

Practical
Botany of crops, Floral biology, emasculation and hybridization techniques in different crop species, viz. wheat, oat, rapeseed and mustard, pulses, potato, sugarcane, tomato, chilli, onion etc. Study of field techniques for seed production and hybrid seed production in rabi crops; Estimation of heterosis, inbreeding depression and heritability; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops. Case studies of IKS-based seed production in different rabi crops.

Suggested readings
1. Breeding Field Crops -I by V.L. Chopra
2. Genetic Improvement of Field Crops by C.B. Singh and D. Khare
3. Genetics and Breeding of Pulse crops by D.P. Singh
4. Vegetable Breeding – Principles and Practices by Hari Har Ram
5. Breeding Field Crops by D.A. Sleper and J.M. Poehlman
6. Plant Breeding –Theory and practice by S.K. Gupta
7. Breeding Asian field Crops by J.M. Poehlman and D.N. Barthakur
8. Practical Manuals on Crop Improvement I (Rabi crops) by Rajendra Kumar Yadav

AEG-321	Renewable energy in Agriculture and Allied Sector	1+1

Objectives
1. To gain the knowledge on different types of materials used in Renewable Energy
2. To understand the importance of Renewable Energy technology and its applications
3. To train the students on the applications of solar thermal technology

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. Availability of bio mass and their application in different places. Indian Knowledge System Based energy sources and their contribution in agriculture sector, and traditional technology for utilization of agricultural biomass as energy sources. Controlled energy extraction from agricultural biomass using traditional Indian knowledge systems.

Practical
Familiarization with renewable energy gadgets. To study biogas plants, gasifier, production process of biodiesel, briquetting machine, production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing, solar cooker and solar drying system. To study solar distillation, solar pond and solar wind hybrid system. Field visit to Solar –Wind farm.

Suggested readings
1. C.S. Solanki. 2011. Solar Photovoltaic – Fundamentals, Technologies and Applications. PHI Learning Pvt. Ltd.

2. S. Sukhatme and J. Nayak. 2008. Solar Energy: Principles of Thermal Collection and Storage. Third Edition (Tata McGraw-Hill).
3. V.V.N. Kishore. 2008. Renewable Energy Engineering and Technology: Principles and Practice, Teri, India.

AGR-321	Dryland agriculture/Rainfed agriculture and watershed	1+1

Objectives
1. To learn about characteristics and conditions of dryland/rainfed agriculture
2. To gain knowledge about drought and its mitigation
3. To impart knowledge on water harvesting and watershed management

Theory
Dryland/Rainfed agriculture: Introduction, types and characteristics; History of dry land/rainfed agriculture in India; Problems and prospects of dry land/rainfed agriculture in India; Soi land climatic conditions prevalent in dry land/rainfed areas; Length of Growing Period (LGP)and Soil Moisture Availability (SMA) and its impact on crop and cropping system; Soil andwater 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; Crops and cropping systems in dry land/rainfed areas; Management of crops in dry land/rainfed areas; Contingent crop planning for aberrant weather conditions; Concept, history, objective, principles and components of watershed management, factors affecting watershed management. Long-term rainfall analysis in relation to simple mathematical models and forecasting the weather abnormalities; Alternate land use system location; regional and crop specific dryland principles and practices for profitable and sustainable dryland farming and allied enterprises. IKS: water harvesting structures used by ancient time like construction of artificial bunds (ponds), “Dighi (Pukur), “Indara” (large size well made by boulders), check dams, “Happa / Dhora” (small ponds); water conservation through Achadan (mulching) materials which were locally available like dry leaves, straw, rice chaff, ash etc

Practical
Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Calculation of Length of Growing Period (LGP)and Soil Moisture Availability (SMA) 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 including mechanical and agronomic measure. Soil moisture determination under different land situations, Importance of seed priming to mitigate drought. Assessment of meteorological drought. Characterization and delineation of model watershed. Seed treatment, viz., seed hardening and seed priming techniques for all the agricultural crops Field demonstration on soil and moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

Suggested readings
1. A.K. Srivastava and P.K. Tyagi. 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
2. D. Lenka. 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
3. G.S.L.H.V. Prasad Rao. 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi. 4. H.S. Mavi and Graeme J. Tupper. 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
5. H.S. Mavi. 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. H.V. Nanjappa and B.K. Ramachandrappa. 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
7. S.R. Reddy. 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.
8. T. Yellamanda Reddy and G.H. Sankara Reddi. 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.

PPC-321	Agricultural Microbiology and Phyto-remediation	1+1

Objectives

1. To get an introduction to microbiology with specific focus on its significance in agriculture science
2. To get acquainted with the bacterial structure and the function of the different bacterial components
3. To get highlights on different fields of microbiology
4. To get highlights on the bioremediation of polluted soils using microbial mediators and phytoremediation
5. To get a concept of biological control and the role of biopesticides in plant disease management.

Theory
Introduction to Microbiology: Definition, applied areas of Microbiology and Importance of Microbiology. Ancient Indian Practices for Phytoremediation. History of Microbiology: Discovery of microorganisms, spontaneous generation theory, Germ theory of diseases, Immunization, fermentation, and origin of life. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, genetic engineering. Soil Microbiology: Nutrient mineralization and transformation, Air Microbiology: Phyllosphere microflora, Phylloplane microflora, microflora of floral parts etc. Food Microbiology: Microbial spoilage and principles of food preservations, Food poisoning. Water Microbiology: Types of water, water microorganisms, and microbial analysis of water e.g. coliform test, Purification of water. Industrial Microbiology: Microbial products, Biodegradation, Biogas production, Biodegradable plastics etc. Biological control: Microbial biopesticides for plant disease management Concepts of rhizosphere microbiology- Rhizodeposits - biochemical nature, release mechanism in rhizosphere, function, Carbon flow in rhizosphere, Rhizosphere microbiomeresidents and their roles. Potential of plant growth promoting rhizobacteria (PGPR) and endophytes on soil health and sustainability. Bioremediation of polluted soils using microbial mediators. Phytoremediation of polluted soils.

Practical
Study of the microscope; Acquaintance with laboratory material and equipment; Microscopic observation of different groups of microorganisms: moulds (Fungi); Direct staining of bacteria by crystal violet; Negative or indirect staining of bacteria by nigrosin; Gram staining of bacteria; Study of phyllosphere and rhizosphere microflora; Measurement of microorganisms; Preparation of culture media; Isolation and purification of rhizospheric microbes; Isolation and purification of N-fixers; Isolation and purification of Nutrient solubilizers; Isolation and purification of Endophytes.

Suggested readings
1. `Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2002. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.
2. `Rangaswami, G. and Bagyaraj, D. J. 2005. Agricultural Microbiology. Prentice-Hall of India Pvt. Ltd., New Delhi.
3.` Mukherjee, N. and Ghosh, T. 2004. Agricultural Microbiology. Kalyani Publishers, Calcutta
4. `Dubey, H.C. 2007. A Textbook of Fungi, Bacteria and Viruses. Vikas Publishing House Ltd., New Delhi – 10014
5. `Salyers, A. A. and Whitt, D. D. 2001. Microbiology: diversity, disease, and the environment. Fitzgerald Science Press, Inc. 6. Prescott, L. M. 2002. Microbiology 5th Edition. McGraw-Hill Inc, US

AECo-321	Agricultural Finance & Cooperation	1+1

Objectives
To impart knowledge on issues related to lending to priority sector credit management and financial risk management

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 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. 3 R's, 5 C's and 7 P's of credit. Crop insurance: its scope, significance and limitations and the potential of the newly launched 'Pradhan Mantri Fasal Bima Yojana' (Prime Minister's Crop Insurance Scheme). Successful cooperative systems in Gujarat (AMUL), Tamil Nadu (Aavin), Karnataka (Nandini), Maharashtra and Punjab. Core Principles of IKS in Agricultural Finance & Cooperation; History of rural finance in India (Bhisi, Kuri, Chit, Taccavi, micro-finance, etc); Indigenous rural credit lending practices (Gotul, Guthi, Kudambasree, Gandhian & Sarvodaya principles); Ethics and interest regulation in ancient texts; Indigenous Models of Cooperation in Indian Agriculture (Kudimaramathu; Gotra farming; Phad system; Panchayats, etc). Historical institutions of financial risk management (Ritual calender, temple-based endowment, community storage, etc).

Practical
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 first-hand 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. Different types of repayment plans.

Suggested readings
1. Gittinger, J.P. 1982. Economic Analysis of Agricultural Projects. The Johns Hopkins Univ. Press.
2. Reddy, S. S. and Ram, P.R. 1996. Agricultural Finance and Management. Oxford & IBH.

ACB-321	Essentials of Plant Biochemistry	2+1

Objective
To impart the fundamental knowledge on structure and function of cellular components, biomolecules and the biological processes in plants

Theory
Biochemistry – Introduction and importance, Properties of water, pH and buffer, plant cell and its components. Bio-molecules – Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids. Vitamins – physiological and metabolic role. Enzymes: General properties; Classification; Mechanism of action; Michaelis and Menten and Line Weaver Burk equation and plots; Introduction to allosteric enzymes, use of enzymes. Metabolic energy and its generation – Metabolism – Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. Biosynthetic Pathways – Photosynthesis, Gluconeogenesis, nitrogen fixation, fatty acid and starch formation. Regulation of metabolic pathways. Secondary metabolites, Terpenoids, Alkaloids, Phenolic and their applications in food and pharmaceutical industries.

Practical
Preparation of standard solutions and reagents, Determination of pH, Qualitative tests of carbohydrates and amino acids, Quantitative estimation of soluble sugars and starch, Estimation of protein by Kjeldhal method and Lowry's method, Preparation of mineral solution from ash, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Qualitative/quantitative tests of secondary metabolites.

Suggested reading
1. Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman (Can be downloaded)
2. Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley
3. Horton, Moran, Rawn, Scrimgeour, Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded)
4. Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded)
5. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.

CPH-321	Fundamentals of Seed Science & Technology	1+1

Objectives
To impart basic and fundamental knowledge on principles and practices seed science and technology
To impart practical skills on scientific seed production and post-harvest quality management

Theory
Introduction to seed technology, definition and importance; Seed quality -definition, characters of good quality seed; Causes of deterioration of varietal purity and assessment of genetic purity, different classes of seed. Foundation and certified seed production of important cereals, pulses and oilseed, field inspection, importance and procedures; Post-harvest seed quality management; seed processing procedures, seed drying; Seed treatment, its importance, method of application and seed packing; seed storage - general principles, Indigenous traditional knowledge on seed treatment and storage. Relevance of Vṛkṣāyurveda and other traditional methods for organic production of healthy seedlings. stages and factors affecting seed longevity during storage; Seed health management during storage. Seed Certification and legislation; Seed Act and Seed Act enforcement, duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, basics of seed quality testing; New Seed Bill 2019; Seed quality enhancement techniques.

Practical
Seed Structure, Seed sampling, Physical purity, Moisture determination, Germination test, Seed and seedling vigour test, Seed Viability, Genetic purity test: Grow out test, Field inspection, Seed health testing using blotter and agar plate method. Visit to seed production farms, seed testing laboratories and seed processing plant.

Suggested Readings

1. Agarwal, R.L. 1995. Seed Technology (2nd edition). Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, India.
2. Khare, D. and Bhale, M.S. 2019. Seed Technology (2nd revised & enlarged edn), Scientific Publishers, ISBN: 978-81-72338-84-8, New Pali Road, P.O. Box 91, Jodhpur, India
3. Vanangamudi, K. 2014. Seed Technology (An illustrated book), New India Publishing Agency, New Delhi, India.
4. Bhojwani, S.S. and Bhatnagar, S.P. 1999. The Embryology of Angiosperm. Vikas Publ
5. McDonald, M.B. Jr and Copeland, L.O. 1997. Seed Production: Principles and Practices. Chapman & Hall.
6. Tunwar, N.S. and Singh, S.N. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

Learning Outcomes:
1. The students will understand various aspects of seed technology such as quality, production, multiplication, certification, testing, processing, storage, and marketing
2. The students will become aware of different legislative measures which regulate the production and sale of seeds in India
3. The knowledge in seed production technology and marketing will be useful for developing entrepreneurship among students

Semester VII

EC-4101	Principles and Practices of Organic Farming/Conservation Agriculture	3+1

Objectives
1. To teach students the principles of crop production under organic and conservation agriculture situation
2. To impart practical knowledge of organic and conservation agriculture practices

Theory
Concept of organic farming, principles and its scope in India; Choice of crops and varieties in organic farming; Nutrient management in organic farming and their sources; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP;

Certification process and crop standards of organic farming; Processing, labelling, economic considerations and viability, marketing and export potential of organic products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture. Conservation agriculture: definition, origin, principles, advantages, challenges; Primary practices in conservation agriculture: minimum soil disturbance, crop residue retention, and crop diversification, complementary practices, conservation agriculture vis a vis Climate Smart Agriculture; Organic manures- recommended doses and application in comparison to inorganic fertilizers for major crops.

Practical
Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost and their quality analysis; Method of application of bio-fertilizers; Indigenous technology knowledge (ITK) for nutrient, insect-pest and disease management; Studies on green manuring in-situ and green leaf manuring, Studies on different types of botanicals for insect pest management; Weed management in organic farming; Cost of organic production system; Practices of conservation agriculture.

Suggested readings

1. A.C. Gaur. Handbook of Organic farming and biofertilizers.
2. A.K. Dahama. Organic Farming for Sustainable Agriculture. Agrobios (India), Jodhpur.
3. Arun. K. Sharma. Handbook of Organic Farming. Agrobios (India), Jodhpur.
4. S.P. Palaniappan and K. Annadurai. Organic Farming – Theory and Practice. Scientific Publishers. Jodhpur.
5. U. Thapa and P. Tripathy. Organic Farming in India- Problems and Prospects. Agrotech publishing agency, Udaipur.
6. G.K. Veeresh. Organic Farming. Foundation Books. New Delhi.
7. Purshit, S.S. Trends in Organic Farming in India. AgrosBios (India), Jodhpur.
8. Thampan, P.K. Organic Agriculture. Peckay tree Crops Development Foundation, Cochin, Kerala.
9. Sathe, T.V. Vermiculture and Organic Farming. Days Publishing House, New Delhi.
10. Singh, Abhinandan, Pankaj Kumar Ojha and Rahul Kumar, 2018. Conservation Agriculture Technologies. Biotech Books.
11. Acharya Sankar Kr, Sreemoyee Bera, Cornea Saha, Prabhat Kumar, Monirul Haque, Riti Chatterjee and Anwesha Mandal. 2022. Conservation Agriculture Approach and Application. Scholars World. 292p.

EC-4102	**Advances in Crop Production**	**3+1**

Objectives:
1. To teach the students some advanced understanding of crop production.
2. To acquire the knowledge of economics and energetic of sustainable crop production.

Theory
Crop plants in relation to environments; Climate resilient agriculture. Crop growth and development; concept of growth analysis; growth variables - RGR, CGR, NAR, LAI, LAD, RLGR, grain filling efficiency (G), and harvest index (HI); light interception and utilization efficiency; potential crop productivity; Canopy architecture, light interception and utilization, energy use efficiency optimum LAI, critical and ceiling LAI. Agro-biological principles, 318N concept, Mitscherlich yield equation, inverse yield nitrogen law and their interpretations, concept of Baule unit; Physiological limits of crop productivity; crop growth modelling; crop production under problem soils-salt affected soil, acid soils, water logged soils and degraded soils. Resource conservation technology including modern concept of tillage, principles of conservation agriculture; Crop residues and their management; Soil health management in crop production, concept of balanced nutrition and integrated nutrient management. Strategies for improving nutrient use efficiencies. Cropping system approach in crop production, issues and concerns of sustainability in crop production, ecological basis of sustainable crop production. Good Agricultural Practices (GAP) in crop production - concept, definition, objectives, key elements, potential benefits and challenges.

Practical
Plant sampling for the measurement of dry matter production, LAI, LAD, CGR, NAR of different field crops. Measurement of light interception by crop plants. Preparation of calendar of operations for different individual crops. Preparation of crop calendar/cropping programme for different land

situations. Economics and energetics of crop production; Estimation of crop residues of different crops, handling of crop residues. Visit to crop fields of different problematic soils.

EC-4103	Climate Resilient Agriculture	3+1

Objectives

1. To impart the concept of climate resilient agriculture under the present context of climate change
2. To study the integrated role of different sectors in building resilience to climate change in agriculture

Theory

Climate change and impacts of climate change on agriculture and food security; crop productivity under different climate change scenarios including extreme events such as drought, flood, pest and disease outbreak etc. Basics of adaption and mitigation in the agricultural sectors; analyzing and assessing climate vulnerability to identify vulnerable sectors and possible adaptation options in agriculture; assessing biophysical and socio-economic impacts on agricultural sector; risk assessment strategies, preparedness for weather and climate risks in agriculture; application of geospatial tools and techniques for sustainable agriculture. Climate resilient agriculture (CRA)– concept, scope and importance with special reference to India, climate resilient technologies for enhancing crop productivity and sustainability – role of weather and climatic information, agro-advisories, ICTs and simulation models; climate resilient agronomic practices – crop/cultivar selection, crop diversification/ crop mixtures; water management practices – rain water harvesting, micro-irrigation, deficit irrigation and drainage management, organic/natural farming, integrated farming systems (IFS); site specific nutrient management (SSNM), conservation agriculture technologies to build soil organic carbon, harnessing microbial biodiversity, biomass recycling; use of renewable sources of energy.

Practical

Acquaintance with meteorological instruments including AWS, Statistical techniques to study trend of climatic parameters, Analysis of extreme weather events using non-parametric tests, Building climate change scenarios under different futuristic emission of GHGs, Designing strategies to mitigate the effect of climate change using climate resilient crops/cultivars, Climate resilient technologies and manipulation of cropping patterns, Acquaintance with ICTs for effective dissemination of local weather information and agro-advisories, Awareness programme on climate change and climate resilient agriculture among farming community.

Suggested readings

1. Climate Resilient Animal Agriculture by GSLHV Prasada Rao. New India Publishing Agency.
2. Climate Resilient Agriculture Adaptation and Mitigation Strategies by Bhan Manish. New India Publishing Agency
3. Climate-Smart Agriculture Sourcebook. FAO (2013).
4. Implications for Climate Smart Agriculture by Wahid Hasan, Sachin G. Mundhe, Abdul Majid Ansari and Shivani Kumari. Biotech Books, 357p.
5. Climate Resilient Agriculture, Adaptation and Mitigation Strategies by Manish Bhan. New India Publishing Agency, 294p.
6. Climate Change and Agriculture Over India by Prasad Rao. PHI Learning, 352p.
7. Climate Smart Agriculture for Sustaining Crop Productivity and Improving Livelihood Security by Prakash M. Satish Serial Publishing House.178p.

EC-4104	System Simulation and Agro-advisory	3+1

Objectives

1. To impart the knowledge of statistical and simulation modelling in crop yield estimation
2. To get acquainted with different weather forecasting techniques and their usability analysis
3. To study about the preparation and dissemination of agro-advisory bulletin

Theory

System approach for representing soil-plant-atmospheric continuum, system boundaries. Crop models, concepts and techniques, types of crop models, data requirements, relational diagrams. Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis. Potential and achievable crop production- concept and modelling, techniques for their estimation. Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance. Weather forecasting, types methods,

tools and techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop- Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast. Use of crop simulation model for preparation of Agro- advisory and its effective dissemination.

Practical
Preparation of crop weather calendars. Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts. Working with statistical and simulation models for crop growth. Potential and achievable production; yield forecasting, insect and disease forecasting models. Simulation with limitations of water and nutrient management options. Sensitivity analysis of varying weather and crop management practices. Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast. Feedback from farmers about the agro- advisory.

Suggested readings

1. Introduction to Agrometeorology by H. S. Mavi.
2. Agricultural Meteorology by G.S.L.H.V. Prasado Rao.
3. Advances in Plant Atmospheric Interactions (Eds. Rao, V.U.M., Rao, A.V.M.S., Rao, G.G.S.N., Ramana Rao, B.V., Vijaya Kumar, P. and Venkateswarlu, B), Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad.
4. Text Book of Agricultural Meteorology by M.C. Varshneya and P.B. Pillai. ICAR.
5. Principles of Agricultural Meteorology by OP Bishnoi.

EC-4105	Agri-Business Management	3+1

Objectives
To impart knowledge on understanding the concepts processes, significance, and role of management and organizational behaviour

Theory
Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management: Importance and needs of agro-based industries. Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries. Agri-value chain: Understanding primary and support activities and their linkages. Business environment: PEST and SWOT analysis. Management functions: Roles and activities, Organization culture. Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, polices procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital management and financial management of Agribusiness. Financial statements and their importance. Marketing Management: Segmentation, targeting and positioning. Marketing mix and marketing strategies. Consumer behaviour analysis, Product Life Cycle (PLC). Sales and Distribution Management. Pricing policy, various pricing methods. Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation. Project Appraisal and evaluation techniques.

Practical
Study of agri –input markets: Seed, fertilizers pesticides. Study of output markets: grains, fruits, vegetables, flowers. Study of product market, retails trade commodity trading, and value-added products. Study of financing institutions- Cooperative, Commercial Bank, RRBs, Agribusiness Finance Limited, NABARD. Preparations of projects and Feasibility reports for agribusiness entrepreneur. Appraisal /evaluation techniques of identifying viable project- Non discounting techniques. Case study of agro- based industries. Trend and growth rate of price of agricultural commodities. Net present worth technique for selection of viable project. Internal rate of return.

Suggested readings

1. Broadway, A.C. and Broadway, Arif, A. 2002. A textbook of Agri-Business Management. Kalyani Publishers
2. Bairwa, S.L. 2016. Objective on Fundamentals of Agri-business Management. Kalyani Publishers

3. Anjan Nishra, Debasish Biswas and Arunangshu Giri. 2019. Agribusiness Management, Himalaya Publishing House, 220p.
4. Shoji Lal Bairwa, Chandra Sen, L.K. Meena and Meera Kumari. 2018. Agribusiness Management Theory and Practices, Write and Print Publications.
5. Virender Kamalvanshi. Agribusiness Management. Random.

EC-4106	Farm Management, Production and Resource Economics	3+1

Objectives

To develop the understanding of production process and the guiding economic principle for agricultural production; to apply the appropriate economic principle under different production scenario to optimize the production process

Theory

Meaning and concept of farm management, Objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms. Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labour income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies, Crop/livestock/ machinery insurance – weather-based crop insurance, features, determinants of compensation.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Linear Programming. 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.

Learning Outcome

Students will be able to acquire necessary theoretical and analytical skills to optimise the agricultural production and analyse the financial health of any farm for possible progress towards maximisation of profit.

Suggested Readings

- Kay, R. D., Edwards, W. M., & Duffy, P. A. (2015). *Farm Management*. 8th ed. New York: McGraw-Hill Education.
- Debertin, D. L. (2012). *Agricultural Production Economics*. 2nd ed. CreateSpace Independent Publishing Platform.
- Olson, K. D. (2011). *Economics of Farm Management in a Global Setting*. Hoboken, NJ: Wiley-Blackwell.
- Nuthall, P. L. (2010). *Farm Business Management: The Fundamentals of Good Practice*. Wallingford, UK: CABI.
- Barkley, A., & Barkley, P. W. (2016). *Principles of Agricultural Economics*. 2nd ed. London: Routledge.
- Cramer, G. L., Jensen, C. W., & Southgate, D. D. (2001). *Agricultural Economics and Agribusiness*. 8th ed. New York: John Wiley & Sons.

EC-4107	International Trade	3+1

Objectives

This course introduces students to international trade theory, the impact of Liberalization, Privatization, and Globalization (LPG) on agriculture, and the role of trade policies and regulations. Students will gain insights into trade barriers, export zones, and key institutions like the WTO, supported by practical exposure to trade data and policy analysis.

Theory

Theory of International Trade, Process of Liberalization, Privatization and Globalization (LPG) – Balance of Payments – Nature and Components of Disequilibrium – Advantages of International Trade – Principal of Comparative Advantage – Trade Barriers – Tariff Rate quotas (TRQ) – Tariffication – Impact of International Trade Policy of International Trade in India – An Over View of Agricultural Exports and Imports In India – Major Constraints – Agro – Export Zones (AEZs) and Special Economic Zone (SEZ) – Export Promotion Council (EIC) – Agricultural Processed Food Export Development Agency (APEDA) – Marine Product Export Development Agency (MPEDA). Emerging Problems in the New Economic Regime – WTO- History and components, TRIPS, TRIMS, SPS, AoA, GATS, MFN and regional co-operation like EEC, SAARC, ASEAN. Pre-Shipment Inspection – Hazard Analysis Critical Control Point (HACCP). International Marketing Channels – International prices (fob and cif) Market Intelligence in International trade

Practical

Visit to Export units, Regional Export Promotion council, AEZs and SEZs. Collection and analysis of data on Exports, Imports and Prices. Exim Policy of the Govt – Group Discussion. Estimation of BOP, BOT and TOT over time.

Course Outcomes

By course end, students will understand core trade principles, assess trade policy impacts on agriculture, and navigate regulatory frameworks. They will be skilled in trade data analysis, preparing them for roles in policy, trade analysis, and export development in the agricultural sector.

Suggested Readings

- Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2018). *International Economics: Theory and Policy*. 11th ed. Pearson.
- Bhagwati, J., & Panagariya, A. (2013). *Why Growth Matters: How Economic Growth in India Reduced Poverty and the Lessons for Other Developing Countries*. PublicAffairs.
- Salvatore, D. (2016). *Introduction to International Economics*. 4th ed. Wiley.
- Coughlin, C. C., & Wood, G. E. (2001). *Protection, Regulation, and Globalization*. Kluwer Academic Publishers.
- Todaro, M. P., & Smith, S. C. (2020). *Economic Development*. 13th ed. Pearson.
- Bhagwati, J., & Hudec, R. E. (1996). *Fair Trade and Harmonization: Prerequisites for Free Trade?* Vol. 1. MIT Press.

EC-4108	**Agricultural Growth, Development and Policy Analysis**	**3+1**

Objective

This course provides students with an understanding of agricultural growth, development, and policy analysis within the broader context of economic development. Students will explore the dynamics of agricultural growth, examine development issues such as poverty and inequality, and gain insights into the formation and impact of agricultural policies in India.

Theory

Development Economics – Meaning, Scope and Importance; Economic development and economic growth - divergence in concept and approach; Indicators and Measurement of Economic Development - GNP as a measure of economic growth - New Measures of Welfare - NEW - PQLI - HDI - Green GNP; Criteria for under development; Obstacles to economic development; Economic and Non-Economic factors of economic growth.

Economic development - meaning, stages of economic development, determinants of economic growth; Basic theories of economic growth - Rostow's Stages of Growth, Marx's Stages of Growth, Harrod-Domar Model of Economic Growth; Optimal Economic Growth - Recent Experiences of developing country economies in transition; Role of state in economic development; Government measures to promote economic development; Introduction to development planning. Role of agriculture in economic/ rural development.

Different Development issues: Poverty - Meaning, concept, and types; poverty indices, multidimensional poverty indices (MPI); Inequality – Measurement, Gini coefficient and Lorenz curve; Unemployment – Concept and types.
Agricultural Policies in India: Policy - Meaning, definition, concept, objectives, and types of policies; Agricultural Policies of the State and Central government- Agriculture policy, water policy, price policy, land policy, seed policy, fertilizer policy, credit policy, EXIM policy, industrial policy, etc.

Practical
Analysing successful agricultural development initiatives and development issues of different countries; Practical exercises on calculation of Human Development Index; Practical exercises on Gini coefficient and Lorenz curve; Exercises on calculating poverty indices, multidimensional poverty index (MPI); Group discussion on National Agricultural Policy, Seed Policy, Fertilizer Policy, Credit Policy, EXIM Policy, Industrialization Policy.

Suggested Readings

1. Todaro, M. P., & Smith, S. C. (2015). *Economic Development*. Pearson.
2. Jhingan, M. L. (1998). *The Economics of Development and Planning*. Vrinda Publications.
3. Chakravarti, R. M. (1986). *Under Development and Choices in Agriculture*. Heritage Publishers, New Delhi.
4. Ghatak, S., & Ingersent, K. (1984). *Agriculture and Economic Development*. Select Book Service Syndicate, New Delhi.

Course Outcomes
After the completion of the course the student will be able to-Understand the concept of development and its preference over growth. Visualize how the agriculture sector is performing in this aspect. Understand the motive behind the policies and their implementation.

EC-4109	**Economic Theory**	**3+1**

Objective
This course provides students with foundational knowledge of both microeconomic and macroeconomic theories, with applications in agricultural economics. Students will understand consumer and producer behaviour, market structures, national income accounting, and key macroeconomic issues such as inflation, unemployment, and foreign trade.

Theory
Micro-economics: Meaning and concepts; Theory of Consumer Behaviour – Cardinal Utility Approach, Ordinal Utility Approach, Budget sets and Preferences under different situations; Hicks and Slutsky income and substitution effects; Applications of Indifference curve approach; Revealed Preference Hypothesis; Consumer surplus; Price Consumption Curve, Income Consumption Curve and Engle's Law; Derivation of Demand curve – Elasticity of demand; Controls on prices – price floor and price ceiling ;Theory of Demand – Determinants of Demand, Exception of Demand law, Water-Diamond Paradox, Theory of Value, Snob Effect and Bandwagon Effect.
Theory of Production - Short run and long run production functions; Law of Variable Proportions; Returns to scale; Economies and diseconomies of scale; Theory of Costs – Cost concepts and classification, Cost curves, Relationship between cost and production functions; Difference between Traditional and Modern theory of cost.
Market- Meaning, concepts, and types; Market structures and characteristics; Monopoly, Duopoly, Oligopoly, Monopolistic Competition, Pure Competition, and Perfect Competition; Price and output determination in each market type; Price discrimination; Collusive and non-collusive oligopoly; Cartels and price leadership.
Macro-economics: Meaning, concepts, and scope; National Income - Concepts and measurement; Classical theory of Employment and Say's Law; Keynesian theory of employment; Concept of Effective Demand; Investment and Savings; Basics of Marginal Efficiency of Capital (MEC), Multiplier and Accelerator theory;
Money and Banking; Different measures of Money supply and its determinants; Inflation- Nature, Effects and control. Monetary and Fiscal policy; Unemployment - Theory of Unemployment, Phillips Curve controversy and stagflation. Business cycles: Phases, Causes and impact. Foreign Trade – Balance of Payment, Balance of Trade; Free trade versus Protectionism. Exchange Rate, Terms of Trade and Trade Blocks.

Practical
Estimation of different types of Elasticity of Demand and Supply. Practical Exercise on Consumer surplus. Derivation of demand curve from indifference curve. Practical exercise on Law of Diminishing Marginal Utility and Law of Equi-marginal Utility. Derivation of market equilibrium under perfect and imperfect market. Estimate the national income using different methods. Practical on various economic indicators (e.g., inflation rate, unemployment rate, GDP growth rate).

Learning Outcome
Upon completing the course, students will be equipped to understand the basic concepts of consumer behaviour, consumer choice, and market equilibrium. They will develop decision-making skills for firms regarding product selection and production scale to maximize profits, analyse various market types and their real-world applications. National income concepts alongside macroeconomic theories. Additionally, students will evaluate government policies influencing economic transactions and assess the role of investment as a catalyst for national development.

Suggested Readings:
1. Koutsoyiannis A. *Modern Micro Economics.* Macmillan Press Ltd.
2. Gardner Ackley. 1961. *Macro–Economics Theory.* Macmillan, New York.
3. Ahuja, H.L. (2019). *Microeconomics*. S. Chand Publishing.
4. Dewett, K.K. (2019). *Modern Economic Theory*. S. Chand Publishing.

EC-4110	Basic Research Methodology for Social Sciences	3+1

Objective
This course aims to provide undergraduate students with a foundational understanding of research methodology, particularly focusing on statistical and econometric tools used in social science research with an emphasis on agricultural economics.

Theory
Concept, definition and scope of research methodology in social sciences; Importance and application of research methodology in addressing economic and social issues; Data - Meaning and Types: Time series, cross-sectional, and panel data; Levels of data measurement: Nominal, ordinal, interval, and ratio; Distinction between qualitative and quantitative data.
Sources and Methods of Data Collection - Sources of data: Primary and secondary data; Methods of data collection - Survey methods: Complete enumeration, case study, sample survey, and observation techniques; Data collection tools: Survey questionnaires, interview schedules, structured and unstructured questions, and focus groups. Survey Procedures: Designing questionnaires and survey schedules; Pre-testing questionnaires and the importance of pilot studies; Techniques to reduce non-response bias in surveys.
Sampling Techniques: Probability sampling - Simple random, stratified, cluster sampling; Non-probability sampling: Purposive, convenience, and quota sampling; Determining sample size and understanding sampling error.
Growth Curves and their estimation - Types of growth curves: Linear, exponential, and logistic; Application of growth models in forecasting and trend analysis; Index Numbers: Characteristics and types: Laspeyres, Paasche, Fisher indices; Construction of price and quantity index numbers; Uses of index numbers in analysing economic trends, inflation, and cost of living.
Ordinary Least Squares (OLS) methods of estimation: OLS estimation in simple and multiple regression models; Assumptions of the Classical Linear Regression Model (CLRM) and interpretation of coefficients; Introduction to Econometric Issues: Basic idea about Multicollinearity, Auto-correlation, Heteroscedasticity, Principal Component Analysis, Use of dummy variables and computer/statistical packages for solving practical econometric problems.

Practical
Preparation of Survey Schedule: Designing effective questionnaires and survey schedules; Fieldwork techniques for data collection, including interviewing and observational methods; Selection of Models for Collected Data: Identifying suitable regression models based on data characteristics and research objectives; Estimation of Regression Models: Practical application of Ordinary Least Squares (OLS) for simple regression model; Analysis and interpretation of regression output; Construction of Index Numbers: Calculation of Laspeyres, Paasche and Fisher indices.
Suggested Readings

1. Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics*. McGraw-Hill Education.
2. Koutsoyiannis, A. (2001). *Theory of Econometrics*. Palgrave Macmillan.
3. Wooldridge, J. M. (2016). *Introductory Econometrics: A Modern Approach*. Cengage Learning.
4. Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*. New Age International Publishers.
5. Maddala, G. S. (2001). *Introduction to Econometrics*. Wiley.

Course Outcomes
Upon completing the course, students will be able to understand and apply the fundamentals of research methodology in the social sciences, particularly in agricultural economics. Additionally, students will gain skills in interpreting and critically analysing econometric results for application in decision-making within agricultural economics and policy-making.

EC-4111	Soil and Water Conservation Engineering	3+1

Objectives
To acquaint and equip the students with soil and water conservation techniques, soil erosion problems and control measures, design of irrigation channels, land surveying and levelling.

Theory
Introduction to Soil and Water Conservation, causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal Loss Soil Equation. Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways and their design. Surveying: survey equipment, chain survey, cross staff survey, plotting procedure, calculations of area of regular and irregular fields; compass surveying-calculation of bearings and area; plane table surveying-calculation of area by radiation method; levelling-levelling equipment, terminology, methods of calculation of reduced levels. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical
General status of soil conservation in India. Calculation of erosion index. Estimation of soil loss. Measurement of soil loss. Preparation of contour maps. Design of grassed water ways. Design of contour bunds. Design of graded bunds. Design of bench terracing system. Acquaintance with chain survey equipment; plotting of chain triangulation; plotting of cross staff survey; plotting compass surveying; plotting plane table survey; levelling-calculation of reduced levels, profile levelling. Problem on wind erosion.

Leaning Outcome
This course enables the students to have understanding about the soil degradation and their effects, estimation of soil loss, soil erosion control measures, soil and water conservation technologies, water conveyance systems, land surveying and levelling.

Suggested Readings
1. Mal, B. C. 2014. *Introduction to Soil and Water Conservation Engineering*. 2014. Kalyani Publishers.
2. Michael, A. M. and Ojha, T. P. 2003. *Principles of Agricultural Engineering*. Volume II. 4th Edition, Jain Brothers, New Delhi.
3. Murthy, V. V. N. 2002. *Land and Water Management Engineering*. 4th Edition, Kalyani Publishers, New Delhi.
4. Suresh, R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.
5. Basak, N.N. Surveying and levelling, Tata Mcgraw Hill Education Private Limited, New Delhi publication.

EC-4112	Geoinformatics and Remote Sensing, Precision Farming	3+1

Objectives
1. Enabling students acquire knowledge on basics of remote sensing technique for precision farming applications

2. To provide a comprehensive knowledge of remote sensing, precision farming and its benefits in improving crop production and soil health management

Theory
Introduction and history of remote sensing; sources, Principles of remote sensing, propagation of radiations in atmosphere; Interaction with matter; Application of remote sensing techniques land use soil surveys; crop stress and yield forecasting; Advantages and disadvantages of remote sensing; Remote sensing institutes in India; Basic Concepts about geoinformatics. Data sharing; Expert System: Introduction to expert system, Characteristics and features of expert system, Applications of Expert System, Importance of Expert system, Rule based system architecture; Software Agents; Impact of Block chain and it's concepts; Probability and Statistics: Bayes Theorem, correlation and Covariance, Continuous Random variables and probability distribution function, various forms of distributions, central limit theorem; Basics of Machine Learning: Random forest, SVM, ensemble methods; Basics of Deep learning: various model architectures and it's training aspects; Hyperspectral and Thermal Remote Sensing; Proximal Soil and Crop Sensors.

Practical
Familiarization with different remote sensing equipment and data products, Interpretation of aerial photographs and satellite data for mapping of land resources, Global positioning system (GPS), Basics of Geographic Information System (GIS), Georeferencing of toposheets, Digital soil mapping with different variables, Basics of multivariate data analytics, Principal component analysis and regression applications, clustering methods and geostatistics are essential in agricultural studies.

Suggested readings
1. Data Analytics in Bioinformatics: A Machine Learning Perspective. Editor (s): Rabinarayan Satpathy, Tanupriya Choudhury, Suneeta Satpathy and Sachi Nandan.
2. Machine Learning Approaches to Bioinformatics by Zheng Rong Yang.
3. Text Book of Remote Sensing and Geographical Information Systems by M. Anji Reddy.
4. Precision Agriculture Technologies for Food Security and Sustainability By A El-Kader, M Sherine, M El-Basioni and M Basma.
5. Principles and Theory of Geoinformatics by P.K. Garg. Khanna Publishers. 296p
6. Advances in Geoinformatics Remote Sensing and GIS by Bhunia, Gouri Sankar, Uday Chatterjee and Gopal Krishna Panda. BIO GREEN
7. Artificial Intelligence: Machine Learning, Deep Learning, and Automation Processes by John Adamssen. Efalon Acies.
8. Remote Sensing and Image Interpretation, 6th edn (WSE) Paperback – 1 January 2011, Willey Student Edition.
9. Remote Sensing and Geographic Information by A.M. Chandra and S.K. Ghosh. Narosa.

EC-4113	**Food Science and Nutrition**	**3+1**

Objectives
To impart knowledge on the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration

Theory
Introduction on fundamentals of foods and human nutrition; Basic food groups; Concept of balanced diets; Recommended Daily Allowances (RDA) for various age groups; Biochemical composition, energy and food value of various food grains, fruits and vegetables; Carbohydrates, proteins, fats as nutrients and their interactions; Physio-chemical, functional and nutritional characteristics of essential nutrients- sources and functions, Nutritional requirements, malnutrition, inborn errors of metabolism, deficiency diseases; Digestion, absorption, transport and metabolism of nutrients in human system; Protein quality evaluation. Biochemical and nutritional aspects of vitamins, minerals, nutraceuticals, antioxidant, antinational factors and biochemistry of post-harvest storage, losses during processing. Effect of cooking, processing and preservation on nutrients of different food products, biochemical aspects of food spoilage; Food fads, food safety and quality standards. Enzymes in food industry, food additives, nutritional quality of plant, animal, dairy, marine and fermented products.

Practical

Proximate analysis of foods; calorific value of foods; Estimation of vitamins, phenols and flavonoids, carotenoids, antinutrients like Phytate/ Oxallate, Trypsin and Chymotrypsin inhibitor activities, limiting amino acids in food stuff.

Suggested readings

1. Damodaran, S. and Parkin, K.L. (Ed.). 2017. Fennema's Food Chemistry. CRC Press
2. Gibney, M.J., Lanham-New, S.A., Cassidy, A. and Voster, H.H. (Ed.). 2009. Introduction to Human Nutrition. Wiley-Blackwell.
3. Trueman, P. 2007. Nutritional Biochemistry. MJP Publishers.
4. Rekhi, Tejmeet and Yadav, Heena. 2014. Fundamentals of Food and Nutrition. Elite Publishing House. 257p.
5. Dharmesh Kumar. Food Science and Nutrition. Random.

EC-4114	Industrial and Commercial Entomology	3+1

Objectives

a. To familiarize the students with entrepreneurial opportunities in entomolog particularly in Sericulture, Apiculture and Lac culture.
b. To impart knowledge about the Honeybees, Lac insects and Silkworms including their behaviour, rearing activities, production and management

Theory

Ancient Indian knowledge of Sericulture, Lac culture and Apiculture in the context of Rig veda, Atharva veda, Upanishads, Bhagavad Gita, Markandeya Purana, Raj Nighantu, Bharat Samhita, Arthashastra, Amar Kosha, Manusmriti, Ramayana, Mahabharata and Kalika Purana. Silkworm species of commercial values, morphological character, systemic position, and distribution. Wild semi-domesticated and domesticated species- their host plants and types of silk produced by them. Mulberry silk production- Moricuture including different species, variety, their propagation, cultivation methods and picking of leaves Scientific rearing of silk worm. Requisites for mounting and harvesting of cocoons, Grainage- Procedure for production of Dfls and commercial cocoon production. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection.

Study of important species of honey bees. Beekeeping, pollinating plant and their cycle, bee biology. Apiary box for scientific cultivation of honeybees. Commercial methods of rearing, equipment used in apiculture and seasonal management. Method of honey extraction by using honey extractor. Study of nectar and pollen yielding flora. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee and Economics of bee keeping. Commercial methods of rearing, equipment used in apiculture and seasonal management.

History of lac production; importance, potential of lac production in India; organizations involved in lac production activities; strains of lac insects and lac crops, lac host plant species and their rearing seasons, lac host plant pests and diseases and their management. Basic morphology, taxonomy and biology of lac insect. Steps and operation of lac production, selection of brood lac; inoculation process of lac insects and duration: natural self inoculation, artificial inoculation; Harvesting of lac; Commercial uses of lac. Enemies of lac insect and their management.

Practical

Honey bee species, castes of bees. Beekeeping appliances and seasonal management. Bee enemies and disease. Bee pasturage, bee foraging and communication

Types of silkworms, voltinism and biology of silkworms. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves

Species of lac insect, host plant identification, Identification of other important pollinators weed killers and scavenge. Visit to research and training institutions devoted to Sericulture, Visit to research and training institutions devoted to Lac culture. Equipments for lac production. Coupe system of lac production. Herbarium of host plants of Lac.

Suggestive Reading:

- Dandin SB and K Giridhar. 2014. Hand book of Sericulture Technologies. Central Silk Board, Bangalore, 423p.

- Jolly MS, Sen SK, Sonwalkar TN and Prasad GK. 1980. Non–mulberry Silks. FAO Agicultural Services Bulletin 29. Food and Agriculture Organization of the United Nations, Rome, 178 p.
- Rangaswami G, Narasimhanna MN, Kasiviswanathan K, Sastry CR and Jolly MS. 1976. Food Plants of non-mulberry silkworms. In: *Mulberry cultivation*. FAO Agricultural Services Bulletin. Vol.1, Chapter-13. Rome, Italy. 96 p.
- Atwal AS. 2000. *Essentials of Beekeeping and Pollination*. Kalyani Publishers, New Delhi, Ludhiana, India.
- Abrol DP. 2009. *Honey bee Diseases and Their Management*. Kalyani Publishers, New Delhi, India.
- Abrol DP. 2010. *Beekeeping: A Compressive Guide to Bees and Beekeeping*. Scientific Publishers, India.
- David BV and Ramamurthy VV. 2011. *Elements of Economic Entomology*, 6th Edition, Namrutha Publications, Chennai.
- Sharma KK and Ramani S. 2010. *Recent advances in lac culture*. ICAR-IINRG, Ranchi

EC-4115	IPM and Ecology based pest management	3+1

Objectives

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM and Insecticides.

To train the students in implementing IPM programmes and computation of ETL.

Theory

Economic importance of insect pests and their Categories based on GEP. Causes of outbreaks and resurgence. Methods of detection and diagnosis of symptoms caused by insect-pests. Monitoring: Survey, Surveillance and forecasting of Insect pest. Utility knowledge of pest–host complexes and tritrophic interaction. Niche, Guild, habitat, population dynamics, community and its interaction with ecological factors. Concept of balance of life and Biodiversity. Decision making and Pest risk analysis. Calculation and dynamics of economic injury level and importance of Economic threshold level.

IPM: Introduction, history, importance, concepts, principles and tools of IPM. Cultural, mechanical, physical, legislative, biological, autocidal and chemical control. Ecology based insect-pest management of crops. Practices, scope and limitations of IPM. Recent methods of pests control, semiochemicals, repellents, antefeedents, hormones, attractants, gamma-radiation and genetic control. Importance and principles of resistance, classification, components, types and mechanisms of resistance, Insect-host plant relationships and basis of host plant selection in phytophagous insects.

Role of biotechnology in insect-pest management. Classification, new generations, mode of action and synergism of insecticides, and Insecticides Act 1968-Important provisions. Environmental hazards posed by insecticide application. Appliances and safety measures during handling of pesticides, symptoms of poisoning, first-aid and antidotes.

Practical

Types of distributions of organisms; Working out different biodiversity indices; Crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; Computation of EIL and ETL; Computation Benefit Cost ratio.

Development and validation of IPM module; Estimation of exact quantity of required commercial formulations; Identification of commonly used insecticides and their toxicity level; Different types insecticide formulations and application equipments; Identification of different insect-pests and their natural enemies.

Suggestive Reading

- Dhaliwal GS and Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publishers, New Delhi.
- Koul O and Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.
- Ignacimuthu SS and Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ., New Delhi.
- Norris RF, Caswell-Chen EP and Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.
- Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall, New Delhi.

- Subramanyam B and Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

EC-4116	Agricultural Journalism	3+1

Objectives
To impart knowledge and skill in agricultural journalism

Theory
Journalism – Meaning, nature, importance, and types of journalism. Agricultural Journalism – Meaning, definition, principle, objectives, types, and scope. Similarities and difference between agricultural journalism and other types of journalism. Role of agricultural journalist, Training of agricultural journalist. Qualities of journalist, Role of journalist /journalism in agricultural development and development of newspaper and magazines readers. Newspaper and magazines as communication media: Characteristics, kinds and functions of newspaper and magazines, Characteristics of newspaper and magazines readers. Form, content, style and language of newspaper and magazines, Standard part of newspaper and magazines. The agricultural story: Types of Agriculture stories, subject matter of the agricultural story, structure of the agricultural story. Gathering farm information -Sources of farm information: abstracting from research and scientific materials, interviews, coverage of events. Other sources: electronic media, field study. Success stories definition, nature, components, guidelines of writing a success story. Writing a news story difference between news and feature story, the principle of writing a news story, Inverted pyramid structure. Organizing the material, treatment of the story, writing the news lead and the body. Readability measure-readability ease score, automated readability index, gunning fog index, how to improve readability of articles and stories. Use of photograph in agricultural journalism- Basic principles of photography – composition, exposure, lens, light. Use of artwork (Graphs, charts maps, etc.). Writing the captions. Editorial mechanism: Copy reading, headline and title writing. Proofreading: definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader. Layout – meaning, principles of layout and design.

Practical
Practice in writing an agricultural news story. Practice in writing an agricultural feature story. Covering agricultural events for the information collection. Practice in interviewing for the information collection. Abstracting stories from research and scientific materials and wire services. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading. Practice in headline and title writing. Practising proof reading. Practice in lay outing of newspaper. Testing copy with a readability formula. Visit a publishing office.

Suggested readings
1. Introduction to Journalism by Carole Fleming, Emma Hemmingway, and Gillian Moore.
2. Basic Journalism by Rangaswami Parthasarathy.
3. News Reporting and Editing by K. M. Shrivastava.
4. Professional Journalism by M.V. Kamath.
5. The Journalist's Handbook Book by M.V. Kamath.
6. Farm Journalism and Media Management – Bhaskaran et al.
7. Agricultural Extension and farm Journalism – A K Singh.
8. Farm Journalism – Jana and Mitra.
9. Web Materials.
10. Prepared You Tube videos.

EC-4117	Communication and Information Management	3+1

Theory
Communication – Meaning, Definition, Models, theories of communication. Communication process – concept, elements and their characteristics. Types and Barriers in communication. Communication skills – fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication.

Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development. Barriers in communication.

Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

Development communication- Meaning, definition, areas of Development Communication.

Innovative Information sources and Modern communication media – Internet, Cyber Cafes, CAI, Video and Tele conferences, Kisan call centers, Consultancy clinics, social networks etc and their implication in Extension Communication.

Agricultural Journalism – Meaning, Scope and Importance, Sources of news, Types, Merits and Limitations. Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Media in communication – Role of mass media in dissemination of farm technology. Effect of media mix for Rural People.

Practical
Simulated exercises on communication. Planning and writing of scripts for Radio and Television. Planning, Preparation and Presentation of visual aids, Power Point Slides, Handling of Public Address Equipment (PAE) System, Still Camera, Video Camera and Liquid Crystal Display (LCD) Projector. e-publication, website development.

EC-4118	Emerging Trends in Agricultural Extension	3+1

Objective of the Course:
- To orient the students regarding changing scenario of Agricultural Extension, the emerging areas and approaches of extension in agriculture.
- To provide exposure on analyses of different extension approaches, applying different tools and techniques and visits to the stakeholders

Theory
Agricultural Extension– emerging issues and strategies; Genesis and evolution of agricultural extension worldwide; Genesis and evolution of agricultural extension in India; Women in agricultural extension – role, importance and empowerment; Youth in agricultural extension – role, importance and empowerment; Human resource management and development in extension organisations – meaning, issues and strategies; Changing roles of agricultural extension professionals in the context of WTO- issues and strategies; Participatory extension approaches – RRA, PRA & PLA – meaning, features, principles, techniques; Demand driven extension – meaning, features, model
Reorganized extension system – broad based extension-meaning, concept; Farmer led extension – meaning, features, scope and importance; Farming systems approach & farming situation-based extension – concept, characters, activities, scope; Strategic research and extension plan – meaning, importance; Group led extension – meaning, concepts, procedures, advantages and limitations; Market led extension – meaning, problems in agricultural marketing, characteristics, approaches and strategies; Privatization of agriculture extension services and public private partnership – meaning, problems in public extension, reasons for privatization, approaches, possibilities; Cyber extension – meaning, tools, advantages and limitations; Voluntary organizations in agricultural extension – scope and importance, limitations; Latest rural development and agricultural extension projects and programmes in India; Latest extension models.
Meaning and significance of Indian Knowledge Systems (IKS) in agriculture; approaches to identify, validate, and integrate traditional knowledge into formal extension systems; Integration of IKS in modern extension approaches: Strategies for blending IKS with participatory, group-led, and demand-driven extension methods; Indigenous knowledge in Agricultural Extension – relevance, documentation, and dissemination strategies; community-led innovations and grassroots extension models based on IKS; Integrating traditional ecological knowledge (TEK) in climate-resilient extension models: Emerging role of traditional weather forecasting, cropping calendars, and water harvesting techniques in addressing climate risks.

Practical

Analyses of extension reforms based on funding and delivery matrix; Comparing the features of alternative extension approaches and identification of Suitable Alternative Extension approaches for solving extension problems in a specific farming situation; Analyzing the roles of change agents in

State Department of Agriculture; Analyzing the extension activities at the field level; Analyses of structure and functions of ATMA; Identification of technological needs of farmers through participatory approach; Analyzing the functions of a selected VO/ NGO; Studying role of farm women and rural youth in agriculture in a selected village
Participatory identification and documentation of indigenous farming practices in a village context: Field-based collection and analysis of traditional crop/livestock management, seed storage, and ecological practices; Case study analysis of IKS-based extension interventions: Critical review of initiatives (e.g., Zero Budget Natural Farming, Traditional Rice Varieties Network) that integrate IKS into extension planning.

Learning Outcomes
- Understanding of the emerging areas of agricultural extension, their features and effectiveness
- Learning of different tools and techniques of analyses of extension reforms and programmes, feedback of stakeholders.

EC-4119	Organic Livestock Farming	3+1

Objectives
Understand the principles and values of organic livestock farming. Assess and implement organic practices for livestock management. Design integrated organic livestock systems that promote animal welfare, ecological health, and sustainable food production. Critically evaluate the challenges and opportunities of organic livestock systems in contemporary agriculture.

Theory
Overview of organic agriculture and livestock farming. Principles of organic farming and its regulatory framework. Benefits of organic systems for sustainability. Organic certification processes and requirements. National and international organic standards. Record keeping and compliance for organic livestock producers. Understanding non-GMO, hormone-free, and antibiotic-free practices. The ethics of livestock farming in organic systems. Animal behavior, psychology, and welfare standards. Approaches to disease prevention and veterinary care. Principles of organic animal feed. Sourcing and managing organic feed ingredients. Balancing nutrients in organic livestock diets. Grazing and pasture management for optimal nutrition. Benefits of integrating livestock with crop production. Manure management and composting. Preventive health measures in organic systems. Strategies for disease management without synthetic chemicals. Maintaining biosecurity on organic farms. Alternative medicine and holistic approaches to animal health. Organic breeding programs. Ethical considerations in animal breeding. Economic viability of organic livestock production. Concept of organic product markets and consumer trends. Pricing, marketing, and selling organic livestock products. Opportunities for innovation and growth in the organic sector. Policy for organic livestock systems. Emerging technologies and their impact on organic livestock systems. The role of organic farming in climate change mitigation. Consumer demand and its influence on organic livestock practices.

Practical
Introduction to an organic livestock farm. Identification of livestock breeds commonly used in organic farming. Assessing suitability of livestock breeds for organic systems. Overview of farm operations. Preparing organic feed rations. Identification of common health issues in organic livestock. Hands-on demonstration of administering herbal treatments and organic supplements. Visit to an organic livestock housing system. Building a small-scale organic livestock shelter using sustainable materials. Organic certification: documentation and record-keeping techniques. Practical demonstration of pest control methods. Identifying parasites in livestock and organic deworming techniques. Record-keeping exercises for livestock health, breeding, and production. Creating a marketing plan for organic livestock products. Case studies of successful organic livestock businesses. Ethical evaluation of livestock handling and management practices. Field trip to an organic processing plant. Demonstration of processing and packaging of organic products.

Suggested Readings:
- Practical Guide to Organic Animal Husbandry by R.D. Singh, Agrobios (India).
- Manual on Organic Farming and Integrated Crop-Livestock Management by Indian Council of Agricultural Research (ICAR).
- Organic Farming for Sustainable Livestock Production by K.V. Subrahmaniyan, Springer.

- Organic Livestock Farming: A Guide to Management and Husbandry by R.K. Sood & S.P. Katiyar, ICAR - Indian Council of Agricultural Research.

EC-4120	Climate resilient livestock production	3+1

Objectives

Understand the effects of climate change on livestock production systems, including impacts on animal health, welfare, and productivity. Analyze the role of livestock in greenhouse gas emissions and the potential for mitigation. Identify and apply climate adaptation strategies for improving livestock resilience, including nutrition, breeding, and management practices.

Theory

Overview of climate change science. Key climate change impacts on agriculture and livestock. Effects of temperature extremes and weather events. Livestock behavior and welfare in changing climates. Adaptation measures for animal health. Effects of climate on feed availability and quality. Climate-induced stress and reduced reproductive performance. Impacts on meat, milk, and wool production. Livestock and their role in global warming. Emission mitigation strategies. Policy frameworks: Carbon footprints, offsets, and emissions regulations. Role of livestock in sustainable food systems. Risk management and disaster preparedness in livestock farming. Breeding strategies for heat tolerance, disease resistance, and drought resilience. Genetic improvement of livestock for climate adaptation. Sustainable feed sourcing and supplementation strategies. Climate-smart feeding systems to enhance livestock resilience. Water stress and its effects on livestock productivity. Grazing systems and their role in soil carbon sequestration. Adaptive grazing practices for climate resilience. Land management for improved pasture quality under climate stress. Designing and managing climate-resilient livestock housing. Infrastructure planning for extreme weather events. Innovations in livestock shelters for reducing heat stress and improving animal welfare. Government policies for promoting climate-resilient livestock systems. Climate finance and funding for adaptation and mitigation. Digital tools for monitoring climate impacts on livestock. Role of biotechnology in improving livestock resilience. Vulnerabilities of livestock supply chains to climate change. Risk assessment and management in supply chains. Adapting supply chains for sustainability and resilience. Holistic approach to climate-resilient livestock systems. Integrating climate adaptation across livestock enterprises. Farm-level strategies for improving resilience to climate variability.

Practical

Field tour of a livestock farm affected by climate change. Discussion on observed climate impacts on livestock productivity. Hands-on exercise using climate data to assess livestock vulnerability. Measuring temperature and humidity levels in livestock housing. Designing heat stress mitigation systems. Monitoring livestock behavior for signs of heat stress. Installation and maintenance of rainwater harvesting systems for livestock. Practical demonstration of water-efficient irrigation and drinking systems. Evaluation of alternative feed resources. Setting up biosecurity measures on the farm to prevent outbreaks. Hands-on construction of a simple climate-smart livestock shelter. Evaluating existing farm infrastructure for climate resilience. Use of renewable energy for farm operations. Breeding selection exercises based on climate adaptability traits. Evaluating livestock for climate resilience attributes. Fieldwork in rotational grazing and its benefits for soil and pasture health. Analysis of local and international climate policies for livestock producers. Role-playing and group discussion on advocacy and policy formation.

Suggested Readings:

- *Climate Change and Livestock: Impacts, Adaptation, and Mitigation* by Fiona E. O'Mara & Philip J. McIntosh
- Climate Change and Livestock Production: Impacts, Adaptation and Mitigation", R. R. S. Ranjan, Springer, 2020.
- Sustainable Livestock Production in the Tropics, S. R. Swaminathan, Springer, 2019.
- Indian Agriculture and Climate Change: A Comprehensive Approach to Livestock and Crop Systems, R. S. Khurana, Cambridge University Press, 2020.

EC-4121	Livestock based integrated farming system	3+1

Objectives

Understand the principles and components of Integrated Farming Systems. Be able to design and evaluate IFS models based on different agro-ecological zones. Gain insights into the economic,

environmental, and social aspects of IFS. Application of modern technologies to improve the efficiency of IFS.

Theory
Introduction to Integrated Farming Systems (IFS). Key components of IFS. Livestock integration: role of cattle, poultry, small ruminants, and other livestock. Crops and livestock synergy. Diversification benefits in IFS. Resource cycling in IFS. Matching livestock and crops to the local agro-ecology. Crop residue management and livestock feeding. Livestock's role in pest and weed control. Use of organic fertilizers and bio-pesticides. Manure management systems in livestock-based IFS. Biogas production and its integration into farm operations. Vermicomposting. Wastewater reuse for irrigation and aquaculture. Role of small ruminants in integrated systems. Poultry farming integration with crops and agroforestry. Integrated pest management (IPM) with poultry and small ruminants. Diversification strategies for risk management. Animal disease control and prevention in integrated systems. Integrating health management with other components of IFS. Biocontrol agents and herbal medicines for livestock health. Integration of aquaculture with crop and livestock systems. Integration of trees with crops and livestock for enhanced farm productivity. Cost-benefit analysis and profitability of IFS. Assessing environmental sustainability of IFS. Commonly practiced IFS models. Selection of appropriate IFS models based on regional and farm-specific needs. Government policies and support programs for IFS. Role of digital tools and farm management software in improving IFS efficiency. Identifying barriers to IFS adoption. Climate change and its implications on IFS. Adoption of climate-smart practices and technologies in IFS. Technological advancements and their potential impact on IFS. The future of IFS in the context of sustainable global food systems.

Practical
Field visit to a model farm with an integrated system to observe different components. Identifying and assessing livestock for integration. Case study: Evaluating livestock performance on integrated farms. Preparation of animal feed formulations and feeding plans for different livestock species. Visit to a feed mill or fodder production unit. Preparation and application of organic fertilizers using farmyard manure. Observing and monitoring fish and livestock interactions. Field visit to assess pest and disease management strategies on an integrated farm. Practicing integrated pest management (IPM) techniques and biological control methods. Preparation of farm plans integrating crops and livestock. Preparing economic feasibility reports for various integrated farming scenarios. Market analysis for livestock and crop products in integrated systems. Designing a model integrated farm layout. Practice on maintaining farm records for crops, livestock, and finances.

Suggested Readings:
- Integrated Farming Systems by B. L. Reddy & P. V. Venkataramana
- Sustainable Agriculture and Integrated Farming Systems by S. K. Gupta & V. R. S. Raju
- Agroecology: The Ecology of Sustainable Food Systems by Stephen R. Gliessman
- Integrated Farming Systems for Livelihood Security by M. L. Paroda

EC-4122	**Micro-propagation Technologies**	**3+1**

Objectives
To educate the students in detail about the sterilization techniques for explants, preparation of stocks and working solution, culturing of explants, regeneration of whole plants from different explants and hardening procedures.

Theory
Introduction, History, Advantages and Limitations. Types of cultures (seed, embryo, organ, callus, cell); Stages of micro-propagation; Axillary bud proliferation (Shoot tip and meristem culture, bud culture); Organogenesis (callus and direct organ formation); Somatic embryogenesis; Cell suspension cultures; production of secondary metabolites; Somaclonal variation; Cryopreservation.

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

Suggested readings

1. Basics of Horticulture by Jitendra Singh
2. Introduction to Horticulture by N. Kumar
3. Handbook of Horticulture by ICAR.
4. Plant Tissue Culture: Basic and Applied by Timir Baran Jha and Biswajit Ghosh. Platinum Publishers. 439p

EC-4123	Molecular Diagnostics	3+1

Objectives

To give students a greater understanding of various molecular diagnostic tools, to stimulate their learning of basic concepts in cell and molecular biology y of plants, to make the students familiar with different advanced plant molecular techniques useful in crop physiological research

syllabus

Theory

Introduction and importance of molecular diagnostics. Molecular make-up of cell structure-Ultra structure of cell wall membranes. Molecular organelle- Chloroplast and mitochondrial genomes, microsatellites, micro assays. Plant cell interaction with environmental stresses – biotic and abiotic stresses like drought, cold, salinity, heavy metal- their physiology and molecular bases. Studies on biochemical and molecular markers in crop plants under various stresses – cold stress, heat shock, herbicide stress, and defence against plant pathogens and pests. Signal transduction in plants and transduction molecules in plants. Molecular identification tools for plant diseases, bio-sensors and their

application. DNA fingerprinting and DNA chips.

Practical

Assessment of drought tolerance in crop plants through biochemical and molecular markers. Identification of high protein quality cultivars. Estimation of physiological and biochemical markers under water deficient and moisture stress in crop plants. Plant diseases verification through physiological, biochemical and molecular markers.

EC-4124	Plant Growth Regulators	3+1

Objectives

To impart students a greater understanding of role phytohormones and plant growth regulators in plants;

to stimulate their learning of basic concepts in regulation of plant growth through PGRs; to make the students familiar with the hormonal cross talks and signal transduction and their role in modulation of plant growth and abiotic stress tolerance

Theory

Definition and classification of plant growth regulators- Hormones, endogenous growth substances and synthetic chemicals; Endogenous growth regulating substances other than hormones; Triacontanol, Phenols – polyamines, jasmonates, concept of death hormone. Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene and Brassinosteroids; Signal perception, transduction and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins- germination of dormant seeds, Cytokinins- cell division and retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening. Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Survey of plant growth regulators available in the market. Study of the nature of compounds in commercially available formulations. Methods of application of growth regulators. Extraction of hormones from plant tissue. Auxins- effect on rooting of cuttings, abscission, apical dominance, Gibberellins- effect on germination of dormant seeds, Cytokinins effect on apical dormancy and senescence, ABA effect on stomatal movement, Ethylene-effect on breaking dormancy in sunflower and groundnut. Study of the effect of novel plant growth regulators (Brassinosteroids, Triacontanol, Polyamines etc.) on crop plants.

EC-4125	Diagnostic Physiology	3+1

Theory
Role of plant physiology in plant diagnosis-systematic approach to diagnosing plant damage; Factors causing plant damage – living (biotic) and non-living (abiotic); Response of plants to adverse abiotic factors- deficiency and toxicity of nutrients, light, water, temperature, carbon dioxide, pollutants, heavy metals, salinity, acidity and radiation; Mechanism of tolerance of plants to different abiotic stresses; Plant identification and characterization- growth and appearance of identified plants- normal and abnormal. Deficiency and toxicity symptoms of mineral nutrients in plants. Physiological disorders in major crops. Symptoms- identification, testing, correction and indicator plants; Foliar application of plant nutrients; Hydroponics; Storage disorders- identification, management.

Practical
Identifying the cause of the field problems, Hydroponics under controlled conditions (polyhouse)-preparation and development of symptoms due to nutrient, light and temperature stress, Nutrient diagnostic techniques- deficiency and toxicity symptoms, Identification of physiological disorders in major crops, field identification, Symptoms due to acidity alkalinity and radiation, Rapid tissue testing for nutrient deficiencies, Quantifying the stress damage using instruments- chlorophyll fluorescence meter, infrared thermometer- SPAD meter, Biochemical methods to assess stress damage, Storage disorders- pre-harvest and post-harvest techniques for post-harvest management, Application techniques/ mitigation techniques to manage the stress, On-farm diagnosis of plant damage patterns

EC-4126	**Landscaping**	**3+1**

Objectives
1. To educate the students on designing different styles and types of gardens
2. To enable the students to identify different ornamental plants and their utilization in landscaping design
3. To enable students to design landscapes in softwares like AUTOCAD, ARCHCADE etc.

Theory
Importance and scope of landscaping. Principles of landscaping, garden styles and types terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery water garden, walk-paths, bridges, other constructed features etc. Gardens for special purposes. Trees: selection, propagation, planting schemes, canopy management. Shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture. Climber and creepers importance, selection, propagation, planting. Annuals: selection, propagation, planting scheme. Other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement, management. Bioaesthetic planning: definition, need, planning. Landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions, Bonsai principles and management. Lawn: establishment and maintenance. CAD application.

Practical
Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals; Care and maintenance of plants, potting and repotting; Identification of tools and implements used in landscape design. Training and pruning of plants for special effects. Lawn establishment and maintenance. Layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software. Visit to important gardens /parks /institutes.

Suggested readings
1. Textbook of floriculture and landscaping by Anil K. Singh and Anjana Sisodia
2. Principles of Landscape Gardening: Y. Chandrasekhar and Hemla Naik B. 2020. ICAR.
3. Introductory Ornamental Horticulture and Landscape Gardening: Rajaneesh Singh and Brijendra Kumar Singh. 2020, Bio-Green Books.
4. Principles of Landscape Architecture: Pragnyashree Mishra and Bhimasen Naik. 2022. New India Publishing Agency.
5. Landscape Gardening: Sudhir Pradhan. 2018. Scientific Publishers India.

EC-4127	**Hi-tech Horticulture**	**3+1**

Objectives
1. To educate the students on the latest technology of hi-tech horticulture

2. To educate students on the concepts and prospects of hi-tech horticulture

Theory
Introduction and importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods; Protected cultivation: advantages, controlled conditions, method and techniques; Micro irrigation systems and its components; EC, pH based fertilizer scheduling; canopy management; high density orcharding; Components of precision farming: Remote sensing; Geographical Information System (GIS); Differential Geo-positioning System (DGPS); Variable Rate Applicator (VRA); application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practical
Types of polyhouses and shade net houses, Intercultural operations, tools and equipment identification and application, Micro propagation, Nursery- portrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

Suggested readings
1. Hi-tech Horticulture by T.A. More.
2. Greenhouse Operation and Management by Paul V. Nelson.
3. Hi Tech Horticulture (Pb) by S. Prasad, Dharam Singh and R.L. Bharadwaj. Agrobios
4. Instant Horticulture by S.N. Gupta. Jain Brothers. 488p.
5. Hydroponics for Beginners and Advanced: The Ultimate Hydroponic and Aquaponic Gardening Guide by Tom Garden, Webb Eleanor.

EC-4128	**Protected Cultivation**	**3+1**

Objective
To educate students on the scientific and commercial cultivation of important value-added products in protected cultivation

Theory
Protected cultivation- importance and scope, status of protected cultivation in India and World, types of protected structure based on site and climate. Cladding material involved in greenhouse/ poly house. Greenhouse design, environment control, artificial lights, Automation. Soil preparation and management, Substrate management. Types of benches and containers, Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops-rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants etc. Cultivation of economically important medicinal and aromatic plants. Off- season production of flowers and vegetables. Insect pest and disease management.

Practical
Raising of seedlings and saplings under protected conditions, Use of portrays in quality planting material production, Bed preparation and planting of crop for production. Inter cultural operations, Soil EC and pH measurement. Regulation of irrigation and fertilizers through drip, fogging and misting.

Suggested readings
1. Greenhouse operation and management by Paul V. Nelson.
2. Protected cultivation of Horticultural crops by Madan Kr. Jha, Sujan Singh Paikra and Manju Rani Sahu.
3. Protected Cultivation of Horticulture Crops by Itigi Prabhakar. IBPSS.
4. Advances in Protected Cultivation by Brahma Singh and Balraj Singh. NIPA,252p.
5. Protected Cultivation and Smart Agriculture by Eds. Sagar Maitra, Dinkar J. Gaikwad and Tanmoy Shankar. New Delhi Publishers, 263p.
6. Textbook of Protected Cultivation and Precision Farming for Horticultural Crops by B. Ashok Kumar, Eggadi Ramesh and Sindhu V. Jain Brothers.

EC-4129	**Post Harvest Technology and Value Addition**	**3+1**

Objectives
1. To educate about the different pre-harvest, harvest and post-harvest factors affecting the postharvest life of fruits and vegetables

2. To educate about preparation techniques of value-added products
3. To educate about the different dehydration techniques of horticultural crops

Theory
Importance of post –harvest processing of fruits and vegetables, extent and possible causes of post-harvest losses: Pre-harvest factors affecting post-harvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food (jam, jelly, marmalade, preserve, candy) - concepts and standards; Fermented and non-fermented beverages. Tomato products -concepts and standards; Drying /Dehydration of fruits and vegetables –concept and methods, osmotic drying. Canning – concepts and standards, packaging of products.

Practical
Applications of different types of packing, containers for shelf-life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Preparation of jam, jelly, RTS, nectar, squash, osmotically dried products, fruit bar candy and tomato products, canned products. Quality evaluation of products- Physico-chemical and sensory. Visit to processing unit/industry.

Suggested readings
1. Post-harvest technology of horticultural crops by S.K. Sharma and M.C Nautiyal.
2. Post-Harvest Technology by Suja Nabi Qureshi, Kounser Javeed and Abhay Kumar Sinha. Bioscientific Publishers.
3. Postharvest Technology of Horticultural Crops by K.P. Sudheer and V. Indira. New India Publishing Agency. 320p.
4. Postharvest Management and Value Addition by Aswini Kumar Goel, Rajender Kumar and Satwinder S. Mann. Daya Publishing House.
5. Postharvest Management and Value Addition of Fruits and Vegetables by Kureel M.K. Biotech, 181p.

EC-4130	Commercial Plant Breeding	3+1

Objectives
1. To discuss about hybrid development and various crop improvement aspects of field crops viz., rice, wheat, maize, pearl millet, sorghum, pigeonpea, chickpea, green gram, black gram, lentil, soybean, groundnut, rapeseed-mustard, cotton etc.
2. To provide understanding on tissue culture and biotechnological approaches as alternative strategies for development of line and cultivars
3. To impart Indian knowledge System (IKS) on seed production, release and notification of varieties and PPV& FR Act, 2001

Theory
Indian knowledge System (IKS) of crop varieties, landraces, and their adaptation to local environments, 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 test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Speed Breeding, Breeding Management systems, High-throughput phenotyping and genotyping platforms, IKS-based practices for Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line cultivators: haploid inducer, tissue culture techniques and biotechnological tools. IPR issues in commercial plant breeding: DUS testing and registration of verities under PPV and FR Act. Variety testing, release and notification systems in India. Traditional seed selection and preservation practices, 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. Case studies of IKS-based Commercial plant breeding in different regions.

Suggested readings

1. Commercial Plant Breeding at a glance by Phundan Singh, Pratibha Bisen, Reshu Tiwari. Daya Publishing House.
2. Plant Breeding: Principles and Methods by B. D. Singh. Kalyani Publishers.
3. Principles of Plant Breeding (1st & 2nd Edition) by R.W. Allard.
4. Breeding Field Crops by J.M. Poehlman.
5. Commercial Plant Breeding Objective: Phundan Singh, Mridula Billore and Monika Singh. Astral Publishing, 160p.
6. Breeding and Crop Production: H. Padmalatha, Random. 7. Biotechnology for Agricultural Breeding: Mangal, S. K. GeneTech Books.

EC-4131	Biotechnology of Crop Improvement	3+1

Objectives

1. To acquaint with biotechnological tools of crop improvement
2. To know about direct and indirect methods of gene transfer
3. To introduce about gene editing in plants
4. To provide knowledge about marker assisted breeding and genomic selection

Theory

Impact of Biotechnology on crop improvement and the perspective of society; Various biotechnological techniques available for crop improvement – Plant Tissue Culture, Genetic Engineering, Genome editing, Marker Assisted breeding and Genomic Selection. Biosafety regulations and their application in Agricultural Biotechnology. Somaclonal variation and its use in crop improvement; embryo culture; anther/pollen culture; somatic embryogenesis; artificial seeds; techniques of protoplast culture, regeneration and somatic cell hybridization, achievements and limitations, utility in the improvement of crop plants. Direct and Indirect methods of gene transfer in plants - Agrobacterium-mediated gene transfer in dicots and monocots; Direct DNA delivery methods (microinjection, particle gun method, electroporation); gene targeting; Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems. Introduction to genome editing – Various tools of genome editing; CRISPR-Cas9 with specific emphasis on Indian regulations; Cloning genomic targets into CRISPR/Cas9 plasmids; electroporation of Cas9 plasmids into cells; purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing; in vitro synthesis of single guide RNA (sgRNA); using Cas9/sgRNA complexes to test for activity on DNA substrates; evaluate Cas9 activity by T7E1 assays and DNA sequence analysis; Applications of CRISPR/cas9 technology in crop plants. Marker Assisted Breeding and Genomic Selection: Introduction to various DNA-based markers and their use in marker-assisted breeding; Foreground Selection, Recombinant Selection and background Selection; Marker-assisted backcross breeding, marker-assisted selection – success stories; Introduction to Genomic Selection.

Practical

Agrobacterium-mediated transformation in Tobacco – preparation of construct, transfer to binary vector, transform Agrobacterium, prepare explant, Inoculation and Co-cultivation, antibiotic based selection of putative transformants, validation using PCR; Genome editing- preparation of CRISPR/CAS construct, direct transfer to plant, analysis of the targets; Planning of a MABB programme – selection of parents, crossing strategies, marker analysis.

Suggested readings

1. Brown, T. A. 2006. Genomes (3rd edn). Garland Science Pub, New York.

2. Gene Cloning and DNA Analysis. 2010. Retrieved from http://biolab.szu.edu.cn/ otherweb/ lzc/genetic%20engineering/courseware/b1.pdf
3. Green, M. R. and Sambrook, J. 2012. Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
4. Kumar, Pranav and Mina, Usha. 2015. Biotechnology: A Problem Approach. Pathfinder Publication.
5. Old, R. W., Primrose, S. B. and Twyman, R. M. 2001. Principles of Gene Manipulation and Genomics 7th Edition: Oxford: Blackwell Scientific Publications.
6. Ram, Hari Har. 2019. Crop Breeding and Biotechnology. Kalyani Publications.
7. Rastogi, S.C. 2020. Biotechnology: Principles and Applications. Narosa.
8. Sander, J.D. and Joung, J.K. 2014. CRISPR-Cas systems for Editing, Regulating and Targeting Genomes. Nat Biotechnol. 32:347-355.
9. Singh, K.H., Kumar, Ajay and Parmar, Nehanjali. 2019. Agricultural Biotechnology at a Glance, science technology.
10. Slater. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford, 400p.

EC-4132	Commercial Seed Production	3+1

Objectives

To introduce the basic principles of planting material production at commercial scale and seed quality evaluation

Theory

General Principles of Seed Production: Raising the seed crop, Introduction, Procurement of a class of Improved seeds, Reporting to Monitoring or certification Agency, Principles and practices of selection of area and agronomic requirement of seed production of field crops, Importance of isolation distance and Rouging, Principles of hybrid seed production in field crops, Principles and practices of selection of area and agronomic requirement of seed production of horticultural crops, Concept of apomixes, male sterility and self-incompatibility and its application in hybrid seed production of horticultural crops, Farmers participatory seed production.

General Principles of Seed Processing: Introduction, Objectives of Seed Processing, Seed Drying, Principles of Drying, Water vapour equilibrium, Methods of drying seeds, Cleaning and grading, Air and screen machines, Dimensional separators, Density separators, Surface texture separators, Colour separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids, Seed treatment, Temperature treatment, Chemical treatment, Bagging and Labelling. General Principles of Seed Testing: Seed Testing-Introduction, Procedure of Seed testing, components of seed quality testing genetic, physical, physiological and seed health testing, Seed sampling, Types of seed sampling, Requirements of sampling, Concept of seed viability and vigour; dormancy, types and principles of seed dormancy, Physiological quality of seed, Principles of seed Germination, types of germination, biochemical and genetic basis.

Seed Certification: History, concept and objectives of seed certification; seed certification agency/organization and staff requirement Indian Minimum Seed Certification Standards (I.M.S.C.S.) - general and specific crop standards including GM varieties, field and seed standards.

Seed Industry and Seed Marketing: Introduction, Evolution of the seed industry, Development of the vegetable and Flower seed industry, Seed marketing – concept, definition and purpose, importance and promotion of quality seed, formal and informal seed supply systems, Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins; packaging and labelling, Seed Associations, Factors influencing seed marketing, Seed marketing programs, Seed industry organizations, Marketing of public versus private players, Demand and supply of seed; role of seed replacement rate (SRR), seed multiplication ratio (SMR), economics of seed production; determining seed needs, Seed pricing and price policy, seed processing and / packaging, demand forecasting and factors affecting demand for seeds, effect of price and farm income on seed demand, Role of WTO in seed marketing.

Biotechnology in Seed Technology: History of plant tissue culture, Laboratory organization, Composition of nutrient medium, Micro-propagation, Axillary bud proliferation approach, Meristem and shoot tip culture, Bud culture, Advantages of Micro-propagation, Problems associated with micro-propagation, Synthetic seed production, Types of synthetic seeds, methods of development of synthetic seeds, Components of nutrient media for synthetic seed development, Storage of synthetic seeds, Advantages and limitations of synthetic seed production.

Practical

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate. Operation and handling of mechanical drying equipment; effect of drying temperature and duration on seed germination and storability seed processing equipment; seed treating equipment. Seed production in cross pollinated crops with special reference to land, isolation, Planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in tomato, Hybrid seed production in Maize, detasseling in maize, identification of rogues and pollen shedders, Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc., Visit to seed processing plant and commercial controlled and uncontrolled Seed Stores, Seed industries and local entrepreneurships visit to nearby areas, Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage, detection of seed-borne fungi, bacteria and viruses, identification of storage fungi, control of seedborne diseases, seed treatment methods., Maintenance of aseptic conditions and sterilization techniques, Preparation of nutrient stocks for synthetic media, Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction, Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction, Inoculation of explants for micro-propagation, Inoculation of explants for callus induction and subsequently regeneration of plantlets from matured seeds of field and horticultural crops, Synthetic seed preparation.

Suggested readings

1. Agarwal, R.L. 1997. Seed Technology. 2nd edn. Oxford & IBH.
2. McDonald, M.B. Jr and Copeland, L.O. 1997. Seed Production: Principles and Practices. Chapman & Hall
3. Thompson, J.R. 1979. An Introduction to Seed Technology. Leonard Hill.
4. Singhal, N.C. 2003. Hybrid Seed Production in Field Crops. Kalyani.
5. Justice, O.L. and Bass, L.N. 1978. Principles and Practices of Seed Storage. Castle House Publ. Ltd.
6. Tunwar, N.S. and Singh S.N. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.
7. Chawla, H.S. 2008. Introduction to Plant Biotechnology. 2nd edn. Oxford &IBH publishing Co. Ltd. 113-B Shahpur Jat, New Delhi-110049.

EC-4133	Molecular Genetics and Advanced Plant Breeding	3+1

Theory

(A) Genetics

(1) Architecture of the chromosome and organization of genetic material in eukaryotes and prokaryotes (2) Euchromatin and heterochromatin, supernumerary chromosome and plasmids, position effect (3) Nucleic acids - DNA its chemistry and types (A, B and Z forms), structure, replication and role as genetic material (4) RNA its chemistry and structure. RNA maturation/splicing (5) Gene expression- Protein synthesis: Transcription and translation, Genetic code, (6) Genetic regulation-inducible and repressible systems in prokaryotes. Differences in gene expression between prokaryotes and eukaryotes (6) Biochemical mutations and gene-enzyme relationship, Molecular interpretation of the mutation processes (7) Recombination in bacteria- Transformation, transduction (F-duction) and conjugation (8) Fine structure of gene- genetic units of recombination, mutation and function.

(B) Plant Breeding

(1) Fertilization in angiosperm (2) Incompatibility-sporophytic and gametophytic control of self-incompatibility; basis of incompatibility, breakdown and uses in plant breeding (3) Sterility - types of male sterility (Cytoplasmic, Genetic, Cytoplasmic-genetic, Transgenic and Environmental) and their molecular basis and uses in plant breeding, hybrid sterility (4) Polyploidy – Types, causes, induction and their uses in plant breeding and distant hybridization (5) Heritable and non-heritable components of continuous variation- additive, non-additive and interaction components (6) Concept of heritability and genetic advance under selection (7) Gene frequencies and Hardy-Weinberg equilibrium; Changes in the gene frequencies (8) Theory of selection in the population of cross pollinated crops; Responses to selection. (9) Systems of mating- Assortative, disassortative and random mating and their genetic consequences.

Practical

(1) Pollen sterility, germination of pollen grain in artificial media and study of pollen tube growth. (2) Study and analysis of quantitative characters through suitable statistical techniques. – Estimation of components of genetic variance, heritability (broad sense and narrow sense), genetic advance; t- test, (3) Estimation of gene frequencies and changes in gene frequencies (4) Preparation of different fixatives and stains for chromosome study. (5) Critical study of various stages of mitosis and meiosis and determination of chromosome number with the help of smearing and squash methods. (6) Preparation of permanent slide

EC-4134	Bio-pesticides and Bio-control	3+1

Objective
To generate knowledge about biological control agents, their production and application in crop disease management.

Theory
Definition, history, importance, scope, potential and concepts of bio-pesticides and biological control of crop pests and diseases. Understanding of ecological equilibrium in relation to biological control. Attributes of an ideal bio-pesticides. Different biocontrol agents and their characteristics.

Mechanisms of biological control- Interactions of harmful and beneficial microbes in different habitats. Role of VAM and PGPR in bio-control of plant diseases. Growth promotion – *Pseudomonas* spp., *Bacillus* spp., *Trichoderma* spp. and Actinomycetes.

Classification of biopesticides - Microbes, botanicals and other bio-rationales and their uses. Management of Plant diseases through antagonistic locally available microorganism.

Mass production technology of bio-pesticides- Isolation, purification, identification and maintenance of pure culture of recognized biocontrol agents. Virulence and pathogenicity of entomopathogenic micro-organisms and nematodes.

Methods of application of biopesticides. Methods of quality control of bio-pesticides. Impediments and limitation in production and use of biopesticides

Formulation of different types of bio-control agents and their efficacy. Legislature acts in the production and marketing of biocontrol agents and bio-pesticides. Organic amendments, culture filtrates and botanicals etc. for plant disease management. Entrepreneurship development in the field of bio-control.

Practical
1.Visit to biological control laboratory.
2. Identification of important botanicals.
3. Isolation of bio-control agents from different sources.
4.Pure culturing and evaluation of bio-control potential of isolates.
5.Testing of antibiotic production in culture and in culture filtrate.
6. Identification of entomopathogenic entities in field condition. Quality control of biopesticides
7. In-vitro screening of different bio-agents.
8. Mechanisms of biological control-antibiosis, lysis, parasitism, competition
9. Mass multiplication of biocontrol agents.
10. Assessment of commercial potential of bioagent for crop disease management

Learning Outcome
Eco-friendly management of diseases through Bio-control agents and botanicals and entrepreneurship development among the students.

EC-4135	Management of Natural Resources	3+1

Objectives
1. To enlighten students about available natural resources and their relationship with crop production
2. To impart the knowledge of principles and practices of natural resource management

Theory

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management. Land resources: Land as a resource. Dry land, land use classification, land degradation, man induced landslides, soil erosion and desertification. Landscape impact analysis, wetland ecology and management. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Water ecology and management. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Resource Management Paradigms: Resource management the evolution and history of resource management paradigms. Resource conflicts: Resource extraction, access and control system. Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies. Introduction to soil and water conservation and causes of soil erosion., Definition and agents of soil erosion, water erosion - Forms of water erosion, Gully classification and control measures. Soil loss estimation by universal soil loss equation - Soil loss measurement techniques. Principles of erosion control - Introduction to contouring, strip cropping. Contour bund - Graded bund and bench terracing. Wind erosion - Mechanics of wind erosion, types of soil movement - Principles of wind erosion control and its control measures, Water harvesting techniques - Lining of ponds, tanks and canal systems.

Practical
Identifying natural resources and their utility. Practicing survey - Principles and educating to use pacing technique for measurement. Area calculations through chain survey - GPS demo for tracking and area measurement. Estimation of soil loss and calculation of erosion index. Leveling concepts and practical utility in agriculture. Preparation of contour maps. Concept of vegetative water ways and design of grassed water ways. Wind erosion and estimation process. Different irrigation pumps and their constructional differences. Farm pond construction and its design aspects. Visit to nearby farm pond. Visit to an erosion site. Exposure to strip cropping/contour bunding.

Suggested readings

1. Sustainable Natural Resource Management by Danill R. Lynch.
2. Management of Natural Resource for Sustainable Development, by Vijay Singh Rathor and B S Rathor, Daya Publishing House.
3. Managing Natural Resources: Focus on Land and Water. Ed. Harikesh N. Mishra. PHI, Learning, 496p.
4. Management of Resources for Sustainable Development: Sushma Goel. The Orient Blackswan 284p.
5. Natural Resources: Their Conservation and Management by Arvindrai Upadhyay. Aspiration Academy, 320p.
6. Natural Resource Management for Growth Development and Sustainability by Vasudeva Srishti Pal.Today & Tomorrows Printers and Publishers, 336p.

EC-4136	**Agrochemicals**	**3+1**

Objectives
To impart knowledge on different classes of agrochemicals
To acquaint students about the richness of Indian ayurvedic products in pest control, growth enhancement, restoring soil fertility and controlling deterioration of soil quality.

Theory
An introduction to agrochemicals, their type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture. Herbicides -Major classes, properties and important herbicides. Fate of herbicides. Fungicides- classification –Inorganic fungicides-characteristics, preparation and use of sulphur and copper. Mode of action- Bordeaux mixture and copper oxychloride. Organic fungicides – Mode of action –Dithiocarbamates- characteristics, preparation and use of Zineb and maneb. Systemic fungicides- Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use. Introduction and classification and insecticides: inorganic and organic insecticides organochorine, Ogranophosphates, Carbamates, Synthetic pyrethriods Neonicotinoids, Biorationals. Insecticide Act and rules, Insecticides banned, withdrawn and restricted use. Fate of insecticides in soil and plant. IGR Biopesticides, Reduced risk insecticides, Botanical, Plant and animal systemic

insecticides their characteristics and uses. Fertilizers and their importance. Nitrogenous fertilizers: Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers. Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers: Natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate. Mixed and complex fertilizers: Sources and compatibilitypreparation of major, secondary and micronutrient mixtures. Complex fertilizers: Manufacturing of ammonium phosphates, nitrophosphates and NPK complexes. Fertilizer control order. Fertilizer logistic and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellent.
Use of Indian ayurvedic products for pest control, Plant growth enhancement, soil fertility restoration and management of soil fertility through different organic amendment.

Practical
Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for identification of common fertilizers. Identification of anion and cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available kin market. Estimation of nitrogen in Urea. Estimation of water soluble P2 O5 and citrate soluble P2 O5 in single super phosphate. Estimation of potassium in Muraite of Potash/ Sulphate of Potash by flame photometer. Determination of copper content in copper oxychloride. Determination of sulphur content in sulphur fungicide.

Suggested readings
1. Buchel, K.H. (Ed.). 1992. Chemistry of pesticides. John Wiley & Sons
2. Panda, H. 2022.The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides (Agrochemicals) with Formulae, Manufacturing Process, Machinery & Equipment Details. 2nd Revised Edition. NPCS
3. Biswas, D. R. 2021. A Text Book of Fertilizers. New India Publishing Agency
4. Singh, A. 2022. Basics of Agrochemical Formulations, Brillion Publishing, 176p.
5. Larramendy, M.L. 2017. Toxicity and Hazard of Agrochemicals, INTECH, 170p.

EC-4137	Food Safety and Standards	3+1

Objectives
1. To develop the skills to convert raw materials into safe, attractive food products
2. To manage the production of food products
3. To use scientific knowledge to develop new products

Theory
Food safety –Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Type of Hazards - Biological, Chemical Physical hazards. Management of hazards – Need. Control of Parameters. Temperature Control. Food Storage. Production Design. Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control. Waste Disposal. Pest and Rodent Control. Personnel Hygiene. Food safety Measures. Food Safety Management Tool-Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP.ISO series. TQM- concept and need for quality, components of TQM, Kaizen. Risk Analysis. Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygine. Food laws and Standards Indian Food Regulatory Regime, FSSA. Global Scenario CAC. Other laws and standards related to food. Recent concerns -New and Emerging Pathogens. Packaging, Product labelling and Nutritional labelling. Genetically modified food/transgenic. Organic foods. Newer approaches to food safety. Recent Outbreaks. Indian and International Standards for food products.

Practical
Water quality analysis physico – chemical and microbiological. Preparation of different types of media. Microbiological examination of different food samples. Assessment of surface sanitation by swab/rinse method. Assessment of personal hygiene. Biochemical tests for identification of bacteria. Scheme for the detection of food borne pathogens. Preparation of plants for Implementation of FSMS-HACCP, ISO:22000.

Suggested readings
1. Text book of Food Science and Technology: Avantina Sharma.
2. Handbook of Food Safety: D.S.L. Khatekar and N. Sarkate. Step Up Academy, 576p.

3. Food and Beverage Management: Bernard Davis. Andrew Lockwood, Ioannis Pantelidis, Peter Alcott Routle.dge
4. Food safety and Quality Control: Pulkit Mathur. The Orient Blackswan.332p.
5. Safe Food Handling: HACCP booklet for Food Handlers. Cletus Fernandes, Notion Press

EC-4138	Bioformulation and Nanoformulation	3+1

Objectives

1. To enable students to acquire expertise and skill to develop bioformulation and Nanoformulation
2. To know the importance of biopesticides and biofertilizers
3. To make the students know about various techniques involved in biofertilizers and biopesticides production
4. To get knowledge on essential oils, botanicals, predators, parasitoids, pheromones, and parapheromone and their application in insect pest management
5. To get concepts on agrochemical formulations with nanoparticles and acquaint them with nanotechnology.

Theory

Introduction and history of biological control of pests and diseases; Microbial biopesticides: the global and Indian market scenario; biopesticides for organic agriculture; Different phytopathogenic biocontrol agents: Mode of action; Different entomopathogenic biocontrol agents: Mode of action; Microbial inoculants as biofertilizer candidates, Production, quality assessment and methods of application of biopesticides and biofertilizers; Regulatory system of biopesticides in India; Formulations of plant essential oils, botanicals, pheromone, and parapheromone and their application in insect pest management; Use of predators and parasitoids for insect pest management; Nanotechnology: its applications in pest and disease diagnosis and management; Nano biopesticides: Concept and importance, different techniques of producing nano biopesticides; Nano Fertilizers: Concept and importance, Types of nano fertilizers; Different techniques of producing nano fertilizers; Green synthesis of nano fertilizers; green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles Practical Introduction and acquaintance with biopesticide laboratory; Preparation of culture media; Isolation and purification of bioagent from soil and infected insects; Microscopic study of different microbial bioagents; In vitro assay of microbial bioagents against plant pathogens. In vitro compatibility study among different microbial bioagents; Mass multiplication of biopesticides; Population enumeration of biocontrol agents in different biopesticides; Preparation of plant extracts and their efficacy test against insect pests; Use of pheromone parapheromone for monitoring and management of insect pests; Bioassay of Entomopathogenic biocontrol agents on insect pests; Preparation of microbial inoculants of biofertilizer microbes; Compatibility of biofertilizer microbes; Preparation of solid and liquid consortia of biofertilizer microbes

Suggested readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society.
2. Borkar, S.G. 2015. Beneficial Microbes as Biofertilizers and its Production Technology.
3. Boland, G.J. and David, L.1998. Plant microbe interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
5. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural products.
6. Gnanamanickam, S.S. 2002. Biological Control of Crop Disease. Kuykendall Marel Dekker, INC.
7. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services, Bengaluru.
8. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services, Bengaluru.
9. Allhoff, Fritz and Lin, Patrick (Eds). 2009. Nanotechnology and Society. ISBN: 978-1-4020- 6208-7 Springer Publications, UK.
10. Prasad, Ram, Vivek Kumar, Manoj Kumar and Devendra Choudhary Eds, 2019. Nanobiotechnology in Bioformulations, Kindle Edition
11. Koul, Opender Ed, 2019. Nano-biopesticides Today and Future Perspectives. Academic Press.
12. Shah, M. A. and Tokeer Ahmad. Nano Science and Technology, Wiley India.

EC-4139	Biopesticides and Biofertilizers	3+1

Objectives

1. To provide knowledge on principles, methods, and mechanisms of bio-control agents and their use against plant diseases
2. To provide knowledge on principles, methods, and mechanism of biofertilizers and their use in agriculture

Theory

Biofertilizers - Introduction, status and scope. Structure and characteristics features of bacterial biofertilizers – Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cynobacterial bio fertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers – AM mycorrhiza and ectomycorhiza. Nitrogen fixation –Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. Production Technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers-Storage, shelf life, quality control and marketing. Factors influencing the efficiency of biofertilizers.

History and concept of bio pesticides. Importance, scope and potential of bio pesticides. Definitions, concepts and classification of bio pesticides viz. Pathogen, botanical pesticides, and bio rationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes, Methods of application of bio pesticides. Methods of quality control and Techniques of bio pesticides. Impediments and limitation in production and use of bio pesticides.

Practical

Isolation and purification of important biopestisides: trichoderma Pseudomonas, Bacillus, Metarhyziumetc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides. Isolation and purification of Azospirillum, Azotobactor, Rhizobium, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi- Wet sieving method and sucrose gradient method. Mass production of AM inoculants.

Suggested readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society
2. Bhatnagar, R.K. and Palta, R.K. Earthworm Vermiculture and Vermicomposting. Kalyani Publishers. 3. Boland, G.J. and David, L.1998. Plant Microbe Interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Borkar, S.G. 2015. Beneficial Microbes as Biofertilizers and its Production Technology.
5. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
6. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural Products.
7. Gehlot, Dushyent. Organic Farming: Standards, Accreditation, Certification and Inspection. Agrobios (India).
8. Gnanamanickam, S.S. 2002. Biological Control of Crop Disease. Kuykendall Marel Dekker, INC.
9. Nehra, Sampat. Biofertilizers for Sustainable Agriculture. Aavishkar Publishers, Jaipur, India.
10. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services, Bengaluru.
11. Singh, Awani Kr. Handbook of Microbial Biofertilizers. Agrotech Press, Jaipur, India.
12. Singh, A.K. Organic Farming. New India Publishing Agency, New Delhi.
13. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services, Bengaluru.
14. Trivedi, P.C. Fungal Biopesticides and VAM applications. Pointer Publishers, Jaipur, India.

EC-4140	Management of Agricultural Waste	3+1

Objectives

1. To provide knowledge on types, importance and impact of agricultural wastes
2. To enable students to acquire expertise and skill to manage agricultural waste

Theory
Introduction to agricultural waste management, Nature and characteristics of agricultural waste and their impact on the environment, Kinds of wastes, Classification, role of soil and plants in waste management, sources of waste, impact of waste on soil and plant quality, Biological processes of waste management, Utilization and Recycling of Agricultural waste, Potential of Recyclable Crop Residues and its management, In-situ management of agriculture waste, Composting and Vermicomposting for bio conservation of biodegradable waste, Biogas Technology, Biochar Technology, Agricultural waste and water, air and animal resources, Impacts of waste on human, animal health and environment. Management of bedding & litter, wasted feed, run-off from feed lots and holding areas and waste water form dairy parlors, agrowaste recycling through farming system, waste management machineries, environmental benefit of waste management.

Practical
Collection and preparation agricultural waste sample. Determination of pH, EC, CEC, heavy metals, BOD, COD, TSS, TDS, NH_4, Total P, and dissolved reactive P. Nutrient status (N, P, K, secondary and micronutrients) analysis of agricultural waste. Waste management equipment operation, Maintenance and safety hazards, computer software and models. Survey of different agricultural waste from livestock, dairy, poultry, food processing, fruit & vegetable and agricultural chemicals, Preparation of compost, Vermicomposting, biogas and analysis of compost. Biochar preparation and its characterisation.

EC-4141	**Toxicity and Deficiency of Elements in Soil & Plant and Water Quality**	**3+1**

Objectives
To provide knowledge on toxicity and deficiency of elements in soil & plant and water quality parameters and their management.

Theory:
Introduction, Essential nutrients and their criteria. Classification of nutrients. List of nutrient and plant usable forms, Average concentration of nutrient elements in crops. Nutrient movement to plant roots. Growth Laws and approaches used in plant nutrition. Function of nutrients in plant. Evaluation of soil fertility and plant nutrition - Identification of nutrient deficiencies and toxicities, Plant analysis, Soil tests and critical levels of deficiencies, Nutrient management in intensive agriculture, Integrated nutrient management, Increasing nutrient use efficiency. Quality of irrigation water. Management of poor-quality irrigation water in crop management. Soil and Water pollution.

Practical
Collection and preparation of soil samples. Estimation of pH, EC, Organic C, available N, P, K, S, Ca and Mg, Na and micronutrient and heavy metals viz. Pb, Cd, Ni etc. Plant sampling and sample preparation for analysis. Estimation of total C, N, P, K, S and micronutrient content in plant. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of Calcium and Magnesium in soil and irrigation water.

EC-4142	**Soil Quality Assessment and Management**	**3+1**

Objectives
To acquaint students with basic concepts, principles, components, measurements, and evaluation of soil quality and its management for sustainable agriculture.
To offer valuable insights into different indigenous techniques in soil quality assessment and management.

Theory
Concepts, principles, and components of soil quality - Definition and concepts of soil quality; Soil components – inorganic and organic components; Basic soil quality attributes - Soil texture, Soil reactions , Soil charges, Ion exchange, Buffering capacity, Adsorption-desorption, Microbial turnover, Nutrient cycling; Soil quality indicators - physical, chemical and biological indicators; Methods of soil quality evaluation - Soil quality assessment - need, approaches, procedure of soil quality assessment, site selection, identification of soil quality attributes, soil quality indexing; measurements of soil quality indicators; Management of soil quality for agriculture and environmental quality - Soil quality management for plant production - Soil quality factors, Processes and management – soil acidification, alkalization, soil erosion; Management of soil quality for the environment - Water quality,

Air quality; Management of soil quality for health and food security - Soil quality management for plant health, animal health, human health and food security.
Sustaining soil health through natural practices such as crop rotation, organic manuring (panchagavya, compost), and use of cover crops. Soil texture, colour, smell, and crop performance as ancient indicators of soil quality.

Practical
Measurements of Soil Quality Indicators - Soil sampling; Analysis of Soil Physical Attributes - Soil texture, Depth of soil and rooting, Soil bulk density and filtration, Water holding capacity, Water retention characteristics, Water content; Analysis of Soil Chemical Attributes - Total organic C and N, pH, Electrical conductivity, lime requirement, gypsum requirement, Labile nutrients and metals, Labile contaminants; Analysis of Soil Microbiological and Biochemical Attributes - Microbial biomass C and N, Potentially mineralizable N, Soil respiration, Enzyme activity, Microbial quotient, Microbial respiration quotient. Impacts of indigenous organic inputs (e.g., jeevamrut, green manures) in soil improvement. Comparison of traditional and modern indicators (e.g., earthworm count, root depth) during physical and biological soil quality assessments.

EC-4143	Production, Marketing and Use of Bio-fertilizers	3+1

Objectives
1. To enable students to acquire expertise and skill to produce biofertilizers
2. To know the importance of biofertilizers

Theory
Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- Azospirillum, Azotobacter, Pseudomonas, Rhizobium and Frankia; Cynobacterial biofertilizers- Anabaena, Nostoc and fungal biofertilizers- AM mycorrhiza and ectomycorhiza. Nitrogen fixation - Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers - Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

Practical
Isolation and purification of Azospirillum, Azotobacter, Rhizobium, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi -Wet sieving method and sucrose gradient method. Mass production of AM inoculants. Quality control of biofertilizers.

EC- 4144	Chemistry of biopesticides	3+1

Objectives
To provide knowledge on chemistry of various bioformulation or biopesticides.

Theory
Conventional natural insect control agents such as pyrethrins, rotenone's, nicotine, ryanodine, isobutylamides, sesquiterpenoids, with anolides, clerodanes, quassinoids and limonoids - sources, isolation, characterization, synthesis, application and mode of action. Insect behaviour modifying chemicals (Semiochemicals) –pheromones (sex alarm, trail, territorial, aggregation, etc.). Allelochemicals– allomones, kairomones, synomones, apneumones. Insect hormones – JH, Anti – JH, JH-mimics, feeding deterrents and repellents – both natural and synthetic: Sources, chemistry, mode of action, chemical ecology. Application of biotechnology in pest management (ex. Bt). Phytoalexins, stress metabolites: Sources such as Leguminosae, Solanaceae etc. Acetylene and polyacetylene phytoalexins. Chemistry use and mode of action of natural fungicides, nematicides including photo-activated pesticides like α-terthieyl. Pesticides of microbial origin: Sources, chemistry and mode of action of avermectins, milbimycins and spinosad. Herbicides like biolaphos and phosphonothricin. Phytotoxins like Alternaria alternata toxin, tentoxin, cornexistin, hydantoxidin. Other microbials such as NPV based insecticides.

Practical

Extraction by steam distillation, isolation of pure compounds, their characterization, Extraction of tobacco leaves, isolation of nicotine and its identification, Extraction of neem seed kernels, enrichment of azadirachtin, analysis of azadirachtin and its analysis

EC-4145	Statistical Methods	3+1

Theory

Unit I: Descriptive statistics, Exploratory data analysis, Theory of probability, Random variables, Probability mass function. Probability density function. Mathematical Expectation, Moment generating function. Cumulant generating function.

Unit II: Probability Distribution: Binomial, Poisson, Negative Binomial, Geometric, Uniform, Normal, Exponential, Gamma and Beta.

Unit III: Sampling Distributions: Chi-Square, t and F. Introduction to theory of estimation and confidence-intervals, Parametric tests based on normal, chi-square, t and F distributions. Introduction of Non-parametric tests.

Practical

Exploratory data analysis, Fitting of distributions ~ Binomial, Poisson, Normal. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model.

Suggested Readings

1. Bhattacharya, D. and Roychowdhury, S. Probability and Statistical Inference: Theory and Practice. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
2. Bhattacharya, D. and Roychowdhury, S. Statistics: Theory and Practice. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. Fundamentals of Statistics. Vol. I & II. The World Press Pvt. Ltd.
4. Gupta, S.C. and Kapoor, V.K. Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
5. Hogg, R.V. McKean, J.W. and Craig, A.T. Introduction to Mathematical Statistics. 8th Ed. Pearson.
6. Rohatgi, V.K. and Ehsan, S. An Introduction to Probability Theory and Mathematical Statistics. Wiley Eastern Private Ltd.

EC-4146	Experimental Designs	3+1

Theory

Unit I: Need for designing of experiments, characteristics of a good design. Basic principles of designs randomization, replication and local control.

Unit II: Uniformity trials, size and shape of plots and blocks, Analysis of variance, completely randomized design, randomized block design and Latin square design.

Unit III: Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Unit IV: Split plot and strip plot designs, missing plot techniques in randomized block and Latin square designs; transformations, Introduction of Balanced Incomplete Block Design, Response surfaces, combined analysis.

Practical

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law,
- Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments,
- Analysis with missing data,
- Split plot and strip plot designs.

Suggested Readings

1. Cochran, W.G. and Cox, D.R. 1957. Experimental Designs. 2nd Ed. John Wiley & Sons.
2. Das, M.N. and Giri, N.C. Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Dey, A. 2010. Incomplete Block Designs. World Scientific Publishing
4. Fisher, R.A.1953.Design and Analysis of Experiments. Oliver and Boyd.
5. Gomez, K.A. and Gomez, A.A. Statistical Procedures for Agricultural Research. 2nd Ed. John Wiley & Sons.
6. Gupta, S.C. and Kapoor, V.K. Fundamentals of Applied Statistics. Sultan Chand and Sons.
7. www.drs.icar.gov.in.

EC- 4147	Sampling Techniques	3+1

Theory

Unit I: Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population, Sampling and non-sampling errors.

Unit II: Probability and non-probability sampling, Simple random sampling with and without replacement, determination of sample size, inverse sampling.

Unit III: Stratified random sampling, Cluster sampling, Systematic sampling, Multi-stage sampling, Introduction to PPS sampling, Double Sampling.

Practical

- ϖ Random sampling ~ use of random number tables, concepts of unbiasedness, variance, etc.
- ϖ Simple random sampling, determination of sample size, inverse sampling
- ϖ Stratified sampling, cluster sampling and systematic sampling

Suggested Readings

1. Bhattacharya, D. and Roychowdhury, S. Probability and Statistical Inference: Theory and Practice. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
2. Cochran WG. 1977. Sampling Techniques. John Wiley.
3. Murthy MN. 1977. Sampling Theory and Methods. 2nd Ed. Statistical Publ. Soc., Calcutta.
4. Singh D, Singh P and Kumar P. 1982. Handbook on Sampling Methods. IASRI Publ.
5. Sukhatme PV, Sukhatme BV, Sukhatme S and Asok C. 1984. Sampling Theory of Surveys with Applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

EC-4148	Regression Analysis	3+1

Theory

Unit I: Simple and multiple correlation, partial correlation, rank correlation, Simple and multiple linear regressions: Least squares fit, Properties and examples. Polynomial regression: Use of orthogonal polynomials. Analysis of multiple regression models, estimation and testing of regression parameters, sub-hypothesis testing, restricted estimation.

Unit II: Selection of variables, Stepwise and Stagewise regressions. Adequacy and validation of models. Use of dummy variables, regression with ordinal data. Introduction to non-parametric regression. Logistic regression. Parameter estimation in non-linear models.

Unit III: Regression diagnostics - non-normal errors, non-constant error variances, non independent observations, influential observations (outliers), non-linearity of the model, auto-correlation, DurbinWatson statistic, Heteroscedasticity, multicollinearity in the data. Remedial measures - regression under non-normal errors, transformation of data, generalized least-squares, robust regression, ridge regression, Model over-fitting, model under-fitting.

Practical

- ϖ Correlation and regression analysis,
- ϖ Multiple regression fitting with three and four independent variables,
- ϖ Estimation of residuals, their applications in outlier detection, distribution of residuals,
- ϖ Test of homoscedasticity, normality and autocorrelation,
- ϖ Box-Cox transformation; Restricted estimation of parameters in the model, hypothesis testing,
- ϖ Step wise regression analysis

Suggested Readings

1. Belsley, D.A., Kuh, E. and Welsch, R.E. 2004. Regression Diagnostics-Identifying Influential Data and Sources of Collinearity. John Wiley.
2. Chatterjee, S., Hadi, A. and Price, B. 1999. Regression Analysis by Examples. John Wiley.
3. Draper, N. R. and Smith, H. 1998. Applied Regression Analysis. John Wiley.
4. McCullagh, P. and Nelder, J.A. 1999. Generalized Linear Models. Chapman and Hall.
5. Montgomery, D.C., Peck, E. and Vining, G. 2003. Introduction to linear regression analysis. John Wiley and Sons Inc., New York.
6. Rao, C.R. 1973. Linear Statistical Inference and its applications. John Wiley.

EC- 4149	Data Analysis	3+1

Theory

Unit I: Introduction to various statistical packages: Excel, SPSS, JAMOVI, R etc.. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.
Unit II: Test for normality; Testing of hypothesis: Parametric and nonparametric tests.
Unit III: Data preparation for ANOVA, Analysis of basic designs, Split and strip plot designs, Factorial Experiments, multiple comparisons.
Unit IV: Correlation and regression analysis, Probit and Logit Models, Cluster analysis, Principal component analysis, Neural networks.

Practical
ϖ Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data;
ϖ Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, one-way analysis of variance;
ϖ Designs for Factorial Experiments, fixed effect models, random effect models, mixed effect models, estimation of variance components;
ϖ Linear regression, Multiple regression, Regression plots; ϖ Cluster analysis and Principal component analysis

Suggested Readings

1. Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley.
2. Bhattacharya, D. and Roychowdhury, S. Probability and Statistical Inference: Theory and Practice. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
3. Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmount, California.
4. Chapman & Hall. Chatfield C. 1995.Problem Solving: A Statistician's Guide. Chapman & Hall.
5. Gupta, S.C. and Kapoor, V.K. Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
6. Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall.
7. Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
8. Wetherill GB.1986. Regression Analysis with Applications. Chapman & Hall.
9. http://freestatistics.altervista.org/en/learning.php.
10. http://freestatistics.altervista.org/en/stat.php.
11. http://www.cas.lancs.ac.uk/glossary_v1.1/main.html.
12. http://www.stat.sc.edu/~grego/courses/stat706/. 13.www.drs.icar.gov.in

EC- 4150	Indian Knowledge Systems on Plant Vitality and Consciousness	3+1

Objectives
To acquaint students with the rich body of Indian Knowledge Systems (IKS) describing plant vitality, responsiveness, and regenerative capacities, drawing upon classical texts such as *Vṛkṣāyurveda*, *Krishi-Parāśara*, *Atharvaveda*, and the pioneering experimental contributions of Sir Jagadish Chandra Bose. The course will emphasize documentation, interpretation, and critical reflection on traditional concepts and practices related to plant life.

Theory
Historical perspectives on plant vitality and responsiveness in Indian traditions; Descriptions of *prāṇa* (life force) and plant sentience in *Atharvaveda* and *Ayurveda*; Plant healing, regeneration, and propagation in *Vṛkṣāyurveda*; Agricultural practices recognizing responsiveness and vitality (*Krishi-Parāśara*); Concepts of auspicious plants, sacred groves, and their conservation; Cultural rituals and festivals emphasizing plant responsiveness and symbolic vitality; Contributions of Sir Jagadish Chandra Bose to experimental demonstration of plant responsiveness; Philosophical interpretations of plant consciousness and ethical considerations; Traditional methods of observing and documenting plant movements and health indicators; Relevance of these concepts to sustainable agriculture and biodiversity conservation in India.

Practical
Collection and documentation of scriptural references related to plant vitality and responsiveness; Preparation of annotated translations and explanatory notes; Field visits to sacred groves and culturally significant plant sites;

Observation and recording of traditional practices demonstrating plant responsiveness (e.g., touch-sensitive plants used in rituals); Comparative observation of plants described in classical texts; Preparation of herbarium specimens of culturally important species; Demonstration of traditional methods of plant health assessment; Documentation of rituals and festivals linked to plant responsiveness and vitality; Project report correlating scriptural concepts with practical observations.

Suggested Readings

1. *Vṛkṣāyurveda* (English Translation)
2. *Krishi-Parāśara* (translated editions)
3. *Atharvaveda* (relevant hymns on plant vitality)
4. *Charaka Samhita* (sections describing *beeja* and *prāṇa*)
5. Bose, J.C. (1926). *The Nervous Mechanism of Plants*
6. Bose, J.C. (1927). *Plant Autographs and Their Revelations*
7. Subbarayappa, B.V. *Indian Tradition of Plant Science*. Indian National Science Academy.
8. Selected publications on sacred groves, traditional plant conservation, and cultural practices

Skill Enhancement Courses

SEC-1101	Agro-techniques of Field Crop Production-I	0+2

Objectives:
1. To teach the students the skills of agro-techniques of field crop production.
2. To acquire the knowledge of economics of crop production.

Practical
Crop planning and techniques of raising potato, rapeseed-mustard and lentils in multiple cropping systems: Field preparation, seed treatment and inoculation, sowing/planting, intercultural operations, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, grading, storage and marketing of produce. Preparation of balance sheet of cost of cultivation and net return.

SEC-1102	Mastering NSSO and Survey Analysis	0+2

Objective:
To equip B.Sc. Agriculture students with the practical skills to analyze and interpret unit-level data from NSSO and other major surveys. The course will focus on understanding agricultural and rural data for research, policymaking, and real-world problem-solving.

Practical
Module 1
Foundations of Survey Data Analysis
- Introduction to NSSO and its significance in agriculture
  - o Overview of NSSO and its key surveys (Consumer Expenditure, Employment-Unemployment, Agricultural Census).
  - o Understanding survey design, sampling methods, and structure.

- Basics of Unit-Level Data o Accessing and downloading NSSO unit-level data.
o Tools and software for handling survey data (e.g., STATA, R, Excel).

Module 2: Data Cleaning and Management
- Understanding Variables and Coding
o Identifying key variables for agricultural analysis.
o Handling missing data, data types, and recoding variables.
- Data Cleaning Techniques
o Sorting, filtering, and restructuring NSSO data for analysis.
o Hands-on exercise: Preparing NSSO data for analysis.

Module 3: Data Analysis and Visualization
- Descriptive Analytics o Generating basic summary statistics.
o Computing measures like averages, proportions, and ratios.
- Introduction to Statistical Analysis
o Cross-tabulations, correlations, and basic regressions.
o Case Study: Rural income distribution and agricultural workforce analysis.
- Data Visualization
o Creating charts, graphs, and tables for presenting findings effectively.

Module 4: Reporting and Interpretation
- Preparing Analytical Reports
o Structuring and writing data-driven insights for decision-making.
- Project Presentation
o Students will present a mini-project analyzing a specific NSSO dataset (e.g., agricultural wages, input usage).
o Peer and instructor feedback session.

Outcomes
- Students will learn to handle unit-level NSSO and survey datasets independently.
- They will gain skills in data cleaning, analysis, and visualization using tools like R or STATA.
- Develop a deeper understanding of rural and agricultural development issues through data-driven insights

SEC-1103	**Commercial Horticulture**	**0+2**

Practical

Basic horticultural techniques: preparation of various nutrient / plant growing media, potting and repotting, seedbed preparation, pit preparation and planting, planting design, preparation and application of various agro-chemicals (fertilizers, pesticides, fungicides, herbicides, plant growth regulators etc.) in horticultural crops. Basic knowledge about various horticultural implements, instruments, equipment, machinery and their uses. Planning, establishment and management of orchard and horticulture farm. Storage system. Cool chain and its management. Horticultural processing unit – establishment and management. Different protected structures their construction and management, production of selected horticultural crops (tomato, cucumber, strawberry, chrysanthemum, rose) under protected condition. Cost analysis. Processing methods of seeds and management of seed processing unit. Establishment and management of tissue culture and micro-propagation unit. Marketing arrangements, Export unit, logistics, show room, *kisan mela*, advertising technique, etc. Visit to various commercial units.

SEC-1104	**Repair and maintenance of Farm Machinery**	**0+2**

Practical

Operation of various agricultural equipment, Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Sprayers operation and maintenance, Care and maintenance procedure of agricultural machinery during operation and off-season.

Driving practice of tractor. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Hitching & De-hitching of mounted and trail type implement to the tractor. Introduction to tractor maintenance – precautionary and break-down maintenance. Introduction to trouble shooting in tractors. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage.

SEC-1105	Horticulture Nursery Management	0+2

Practical

Importance of plant propagation. Practice in propagation of plants through seeds. Familiarization with media, implements and containers for plant propagation. Components of nurseries. Selection of site factors for nurseries to be commercial in establishment. Practice of potting/bagging, repotting etc. - packing and transport of nursery materials. Practice in rootstock production, vegetative propagation methods-cutting, budding, grafting, layering etc., and separation of propagules. Other plant parts used for propagation-bulbs, tubers, runners, stolons etc. polyembryonic and apomitic seedlings, Tissue culture techniques. Plant growing structures for propagation. Use of growth regulators for plant propagation. Progeny orchards. Pest and disease management in nursery. Preparation of lay out in establishing of commercial nurseries. Handling-display and sales of plants. Estimation of production costs for different kinds of planting materials. Visit to different types of nurseries. Traditional seed selection and storage techniques using neem leaves, ash, or clay pots. Use of organic rooting hormones like cow dung slurry, honey, or aloe vera extracts; Sacred grove soil (Devrai soil) traditions, high microbial richness for seedling health; **N**akshatra-based planting schedules and local weather forecasting (e.g., observing ant behavior or winds) for nursery timing; Use of ash, cow urine, and herbal decoctions as treatments for seedling diseases.

SEC-1106	Soil, Plant and Water Testing	0+2

Practical

Basic principles of analytical chemistry, Steps of chemical analysis. Collection and preparation of soil, water and plant samples for analysis. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Isolation and viable count of microbes in soil samples. Determination of N, P, K, Ca, Mg, S and micronutrients in plant samples. Estimation of available macro and micronutrient elements in soils and their contents in plants. Determination of Biological oxygen demand (BOD), Total dissolved solids (TDS), Chemical oxygen demand (COD), Nitrates, phosphates and pesticides, Specific ions like chlorides, fluorides and sodium in water. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of Calcium and Magnesium in soil and irrigation water. Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

SEC-1201	Agro-techniques of Field Crop Production-II	0+2

Objectives

1. To teach the students the skills of agro-techniques of field crop production.
2. To acquire the knowledge of economics of crop production.

Practical

Crop planning and techniques of raising rice and maize in multiple cropping systems: Field preparation, seed treatment, nursery raising, sowing/transplating, intercultural operations, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. Preparation of balance sheet of cost of cultivation and net return.

SEC-1202	Unlocking Agri-Data and Forecasting	0+2

Practical

Introduction to Agri-Market Platforms

o Overview of AGMARKNET, e-NAM, and other market data sources.

o Understanding key datasets: price, arrivals, and trade information.
Accessing and Organizing Data
o Downloading data from AGMARKNET and e-NAM portals.
o Using Excel for basic data formatting and organization.
Data Cleaning and Preparation
o Handling missing values, outliers, and inconsistent entries.
o Data preparation using Excel, R, and STATA for analysis-ready datasets.
Basic Analytics and Visualization
o Descriptive statistics using Excel, R, and STATA.
o Visualizing market trends with charts and graphs.
Introduction to Forecasting Techniques
o Fundamentals of time series analysis: trends, seasonality, and patterns.
o Simple forecasting methods using Excel, R, and STATA.
o Practical example: Forecasting price and arrival trends for a selected commodity.
Practical Case Study and Report Preparation
o Group project: Analyzing market data and generating a forecast.
o Preparing actionable insights for farmers, traders, or policymakers.

Outcome
• Students will gain hands-on experience in working with market data using Excel, R, and STATA.
• Develop skills in organizing, analyzing, and forecasting agri-market trends.
• Apply insights to real-world agricultural marketing and decision-making scenarios.

SEC-1203	**Post harvest processing technology**	**0+2**

Practical

Postharvest loss assessment of fruits and vegetables. Familiarization of postharvest maturity indices in various fruits and vegetables. Familiarization on the various harvesting devices employed in fruits and vegetables. Exposure to various packaging materials in fruits and vegetables. Packaging – storage studies in selected fruits and vegetables. Preparation of field level storage structure and its functions Exposure to various storage structures for the storage of horticultural crops. Postharvest handling and value addition of fruits, flowers, vegetables, spices, medicinal and aromatic plants etc. Processing and dehydration of pepper, ginger, turmeric, preparation of white pepper, green pepper, preparation of spice oil and oleoresins. Processing of fruit juice beverages, semi solid and solid produces, tomato products, canned products, dry flowers and other value-added products of commercial importance. Visit to various processing factories and exposure to commercial processing. Traditional storage methods**,** practices like underground pits, mud pots, bamboo baskets, and banana leaf wrapping for short-term storage; Natural preservatives like use of salt, jaggery, turmeric, mustard oil, and vinegar in traditional pickling and preservation; Ethnic fermentation and drying techniques – Explore indigenous fermented products like *amla murabba*, *sundried mango papad*, *kanji*, and *pickle varieties*; Sun-drying techniques using mats, rooftops, and cow dung floors for dehydration of seasonal fruits/vegetables; Eco-friendly **p**ackaging materials like leaves (sal, banana), clay pots, and jute.

SEC-1204	**Bio-fetrtilizer and Biopesticide production**	**0+2**

Practical

Isolation and purification of *Azospirillum, Azotobactor, Rhizobium*, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi- Wet sieving method and sucrose gradient method. Mass production of AM inoculants. Field visit to explore naturally infected species and their isolation in laboratory. Visit to biofertilizer laboratory in nearby area. Quality control of biofertilizers. Identification of entomopathogenic entities in field condition. Isolation and purification of important biopesticides: Trichoderma Pseudomonas, Bacillus and its production. Identification of important botanicals.

SEC-1205	**Organic Production Technology**	**0+2**

Objectives:

1. To teach the students the techniques of growing field crops under organic management.

2. To teach the students the techniques of growing horticultural crops under organic management.

Practical
Techniques of raising field crops and horticultural crops with reference to land selection, collection of seeds/planting materials, seed treatment and inoculation, seed bed preparation, sowing/planting, intercultural operations, nutrient management with organic sources, soil moisture conservation practices, irrigation water management, plant protection measures with cultural, mechanical, botanical and other organic options. Harvesting, threshing and recording yields. Organic certification standards and process, labelling, storing, packaging, transportation and marketing of organic produce. Economics of organic production.

SEC-1206	Surveying and Levelling	0+2

Practical
Surveying: Acquaintance with surveying tools & equipment, scales, geometrical construction. Chain Surveying: Introduction about chain surveying instruments, measurement of distance by a chain and chaining, ranging, chaining on sloping ground, offset and offsetting, obstacles in chain surveying, introduction used for setting out right angles, introduction about triangulation survey, calculation of area of regular and irregular fields. Compass surveying: Identification and parts of instruments in compass survey, determining the bearing of a given triangular plot and calculation of included angles, determining the bearing of a plot and calculating included angles magnetic declination and plotting of compass survey. Plane table surveying: Setting up of plane table and methods of plane tabling, methods of plane table survey, traversing method of plane table survey, locate and plot new building by two point and three-point problem. Levelling & Contouring: General principle, types of levels and their temporary and permanent adjustments. Methods of levelling, reduction of levels, precise levelling and trigonometric levelling; Introduction of contouring, topography and contour, tracing of grade contour, computation of volume.

SEC-1207	Plantation Crop Production and Processing	0+2

Practical
Importance of plantation crops grown in India, historical accent, present status (national and international), future prospects. Role of plantation crops in national economy and export potential. Plant multiplication, nursery raising and management, crop husbandry, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting and advanced processing technology of: Coffee, Tea, Cashew, Rubber, Coconut, Arecanut, Betelvine, Chicory, Chincona, Oil palm, Palmyrah palm etc.

SEC-2101	Production Techniques of Organic Farm Inputs	0+2

Objectives
To teach the students the techniques of on farm preparation of different organic farm inputs.

Practical
Visit to organic farms to study various organic components and their practical utilizations; Production of vermicompost, beejamrit, enriched panchagavya; visit to bio-fertilizers/bio- inoculants production units; Visit to villages to study on indigenous technical knowledge (ITKs) on organic inputs.

SEC-2102	Agripreneurship in Agri-Business	0+2

Objective
To equip B.Sc. Agriculture students with the knowledge and skills to identify, develop, and scale agri-business ventures within the Indian agricultural context. The course emphasizes integrating innovative business practices with traditional agricultural wisdom to address unique challenges and leverage opportunities in India.

Practical
Module 1: Introduction to Agripreneurship in India
 Understanding Agripreneurship

 The role of agripreneurs in India's agricultural and rural development.
Current trends and future scope of agri-business in India.
 Agri-Business Ecosystem in India
 Key players: Farmers, cooperatives, FPOs (Farmer Producer Organizations), agritech start-ups.
 Government policies supporting agripreneurship (e.g., PMFME, eNAM, Agri Infra Fund).
 Identifying Opportunities in Indian Agriculture
 Exploring profitable sectors: Organic farming, precision farming, food processing, and agro-tourism.
 Success stories of Indian agripreneurs: Case studies from different states.
Module 2: Business Planning and Financial Management for Indian Agribusiness
 Crafting a Business Plan
 Components with a focus on Indian scenarios: Market assessment, supply chain logistics, and scalability.
 Hands-on activity: Drafting a business plan for an Indian agri-product/service.
 Accessing Agri-Finance in India
 Schemes and subsidies for Indian farmers and agripreneurs: NABARD, PM-Kisan, Mudra Loans.
 Basics of financial planning: Cost-benefit analysis for small-scale operations.
 Risk Management in Indian Agriculture
 Addressing risks like monsoons, market volatility, and pest attacks.
 Role of agricultural insurance schemes: PMFBY (Pradhan Mantri Fasal Bima Yojana).
Module 3: Marketing and Value Addition for Indian Agripreneurs
 Market Research in the Indian Context
 Analyzing demand for regional crops/products.
 Using digital platforms: Kisan Call Centers, AgriBazaar, eNAM.
 Innovative Marketing Techniques
 Building brands around traditional Indian agricultural products (e.g., GI-tagged items).
 Role of social media and WhatsApp marketing in rural areas.
 Value Addition Opportunities in India
 Processing: Pickles, spices, organic fertilizers.
 Leveraging traditional knowledge: Ayurvedic herbs, dairy products, handloom textiles.
Module 4: Entrepreneurship Skills and Final Project
 Developing Core Skills for Indian Agribusiness
 Leadership, communication, and negotiation techniques in rural contexts.
 Networking with local Krishi Vigyan Kendras (KVKs), NGOs, and self-help groups.
 Sustainability in Indian Agri-Business
 Eco-friendly practices: Zero-budget natural farming, crop diversification, and organic farming.
 Exploring renewable energy options: Solar pumps, biogas plants.
 Capstone Project
 Develop a business plan tailored for an Indian agri-product or service.
 Present and receive feedback from peers, faculty, and industry experts.

Outcomes
 Understanding Indian Agriculture: Students will gain insights into opportunities and challenges in India’s agribusiness sector.
 Practical Business Skills: They will be equipped with tools to craft business plans, secure funding, and market agri-products effectively.
 Value Creation: Students will learn to enhance traditional agricultural products using innovative value-addition techniques.
 Entrepreneurial Mindset: They will be ready to launch agri-startups that address the needs of rural and urban markets in India.

SEC-2103	Agriculture Waste Management	0+2

Practical
Collection and preparation agricultural waste sample. Determination of pH, EC, CECe, heavy metals, BOD, COD, TSS, TDS, NH 4, Total P, and dissolved reactive P. Nutrient status (N, P, K, secondary and micronutrients) analysis of agricultural waste. Waste management equipment operation, Biogas Technology, Waste water treatment: primary, secondary and tertiary treatment, Maintenance and safety hazards, computer software and models. Survey of different agri waste from livestock, dairy, poultry, food processing, fruit & vegetable and agri-chemicals, Preparation of compost, Vermicomposting, briquetting and analysis of compost.

SEC-2104	Post-Harvest Engineering	0+2

Practical

Moisture content in food and its determination by oven drying & other methods. Determination of engineering properties of biomaterials (shape and size, specific gravity, bulk density and porosity, angle of repose). Operations of milling of grains, such as rice, pulses, oilseeds (cleaning, grading, dehusking, polishing). Study of different types of dryers and Different methods of drying: (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer and solar dryer), Study of drying characteristics. Storage systems for grains, Storage of perishable products (cold storage, CA, MA etc.). Value addition concept; Principles and methods of preservation.

Indian Knowledge System of post-harvest handling, storage and preservation -Sun drying of grains and other crops. Indigenous mathods and devices for grain milling (manual winnowing, dheki, chakki, traditional parboling and puffing method, ghani etc.). Indigenous structures and methods of storage of grains and vegetables. Traditional cooling methods like mud pots and underground storage. Traditional methods of pest control during storage of grains and seeds. Traditional practices to enhance shelf life of perishables.

SEC-2105	Beneficial Insect Farming	0+2

Objective

- To acquaint the students about the Importance of Biocontrol agents in Integrated Pest Mnagement
- To acquaint the students regarding the identification of different biological control agents for insect-pests, weeds
- To acquaint the students about the Importance of honey bee, lac insect, insects as pollinators, feed and fodder and other useful byproducts

Practical

Identification of Beneficial Organisms; Predators and parasitoids in biological pest management; Mass Production techniques of Biocontrol Agents - In-vivo Production, In-vitro Production. Application Techniques (Inundative Release and Inoculative Release), Conservation of Natural Enemies; Formulation and Delivery; Liquid Formulations, Granular Formulations, Encapsulated Formulations.

Honeybees : Bee Biology and Behavior, Anatomy and Life Cycle, Social Organization, Pollination Services; Crop Pollination Techniques, Pollinator-Friendly Gardening. Bee Products - Honey Production, Beeswax and Propolis

Lac Insects: Lac Insect Biology, Life Cycle and Host Plants, Resin Formation; Lac Cultivation Practices, Lac Host Tree Management, Harvesting and Processing; Lac Products - Shellac and Other Lac-Based Goods.

Dye-Producing Insects : Cochineal Insects, Natural Red Dye Extraction, Textile and Food Coloring, IKS - Ancient historical background in Dye Production, Modern Applications

Insects in weed management (Parthenium, water hyacinth etc.), Integrated Weed Control Methods, Aquatic Ecosystem Restoration, Identification of insects aiding in pollination

Insects as Food and Feed: Edible Insect Species, Nutritional Profile and Preparation; Entomophagy Practices Worldwide, Insect-Based Animal Feed, Insect Farming for Livestock Feed, Sustainability of Insect Protein, Insect frass as organic fertilizers.

SEC-2106	Participatory Rural Appraisal	0+2

Practical

Participatory Rural Appraisal (PRA)—Definition, Context, Basic Concepts; Rapid Rural Appraisal (RRA); Participatory Rural/Relaxed Appraisal (PRA)-- Principles, Key Areas for Investigation; Analysing Agro-ecosystem – Definition, Properties, Objectives; Basic PRA Tools -- Transect Walk, Seasonal Calendar, Venn Diagram, Process/Flow Diagram, Mobility Map, Daily Routine Charts, Mapping -- Social Mapping, Resource Maps, Topical Maps, Hazard Maps; Time Line, Time Trends; Interviewing; Focus Group Discussions; Preference Ranking -- Matrix Ranking, Wellbeing/Wealth Ranking, Pie Diagram, Proportional Piling, Poverty Ranking; Priority Grid; Opportunity Matrix; Stakeholder Analysis; Constraints Analysis; Gender Analysis; Time Budget Analysis; Resource Flow Analysis; Brainstorming**.** Indigenous Knowledge system: Documentation and Validation of indigenous knowledge in agriculture and Development of QuIK (Quantification of Indigenous Knowledge) Matrix.

SEC-2107	Poultry Production Technology	0+2

Objectives
Develop skills in poultry farming practices, including housing, feeding, and health management. Apply principles of poultry nutrition, breeding, and management to optimize production. Examine modern advancements in poultry production technologies and their environmental impact.

Practical
Overview of poultry industry. Major species and breeds of poultry. Visit to a local poultry farm to observe different production systems. Identifying common poultry breeds and their characteristics. Anatomy and physiology of poultry (digestive system, reproductive system, respiratory system). Behavioral aspects of poultry (social structure, feeding behavior, mating behavior).Principles of poultry housing (ventilation, lighting, space, temperature control). Types of poultry houses (deep litter, battery cages, free-range). Equipment for egg production, brooding, feeding and watering systems. Designing poultry housing. Nutritional requirements for poultry (protein, carbohydrates, fats, vitamins, minerals). Feed formulation and ingredients. Feeding systems and practices for broilers and layers. Nutritional disorders and deficiencies. Formulation of balanced poultry diets (broilers/layers) based on nutrient requirements. Breeding systems and selection for production traits (egg production, growth rate, disease resistance). Hands-on selection of breeding stock. Hatchery management and egg handling. Hands-on experience in incubator and hatchery management. Egg handling, grading, and packaging. Identifying symptoms of common poultry diseases (Bacterial, viral, fungal, parasitic diseases). Preventative health management (vaccination, biosecurity measures). Post-mortem examinations and disease diagnosis. Hands-on vaccination techniques and biosecurity practices. Conducting a disease outbreak investigation. Broiler performance metrics (weight gain, feed conversion ratio). Hands-on demonstration of poultry slaughtering and processing.
Practical application of sanitation and hygiene protocols. Visit to a poultry processing plant. Demonstrating waste management techniques (composting, manure handling). Cost of production, profitability, and financial management of poultry farming. Record keeping in poultry farms (production, health and financial). Setting up farm records and financial statements. Use of farm management software tools. Demonstration of automation in poultry production systems. Opportunities for small-scale poultry producers. Case study analysis on poultry marketing and pricing.

Suggested Readings
1. Jadhav N.V. and Siddiqui M.F. Handbook of Poultry Production and Management. Kalyani Publishers, New Delhi.
2. Shreenivashaiah P.V., Scientific Poultry Production. IBH.
3. Prasad Jagadish, Poultry and Rabbit Production. Kalyani Publishers, New Delhi.
4. ICAR. Handbook of Animal Husbandry. ICAR.

SEC-2108	Floriculture and Landscaping	0+2

Practical
Landscaping, garden styles and types, garden components, terrace gardening, vertical gardening, lawn making, rockery, water garden, sunken garden, walk-paths, bridges, other constructed features etc.. Cultivation of trees, shrubs and climbers, annuals and selected commercial flowers (rose, chrysanthemum, tuberose, marigold, gladiolus etc.). Management of other garden plants: palms, ferns, grasses and cacti succulents. Bio-aesthetic planning, Landscaping of institutes and public places Bonsai, floral arrangements, flower drying, CAD application.

SEC-2109	Formulation of Biopesticides and Botanicals	0+2

Objective:
To train the students with theory and practice of biological control through micro-organisms, mass production techniques and field evaluation of various microbial agents like bacteria, fungi, viruses, nematodes, protozoa etc. & other botanicals.

Practical
Definition, history, importance, scope, potential and concepts of biopesticides and botanicals Classification of biopesticides viz. pathogen, botanicals and biorationals and their uses. Identification of entomopathogenic entities in field condition. Isolation, purification, pure culturing and evaluation of recognized entomopathogenic microorganisms. Isolation technique of micro-organisms from soil and infected insects Mass multiplication of entomopathogenic bacteria, fungi, nematodes and NPV etc. under laboratory condition. Mass production technology of bio-pesticides. Virulence, pathogenicity

and symptoms of entomopathogenic microorganism and nematodes. Methods of application of biopesticides. Methods of quality control and Techniques of biopesticides application. Impediments and limitation in production and use of biopesticide. Identification of important botanicals used in insect pest management. Isolation of botanicals from different sources. Extraction of active ingredients from botanicals (solvent extraction process), stabilization, and application methods for creating market ready products. In-vitro screening of different bio-pesticides and botanicals. Different types of biopesticide and botanical formulation and their efficacy under field level. Visit to a biological control laboratory.

SEC-2201	Organic Production Technology of Medicinal and Aromatic Plants	0+2

Objective
To teach the students the techniques of production of medicinal and aromatic plants under organic management.

Practical
Visit to farms to study various medicinal and aromatic Plants. Study on the indigenous plant based traditional medicines and their uses. Production technology and extraction procedures of major agro-climatologically adapted medicinal and aromatic plants.

SEC-2202	Food Processing	0+2

Practical
Unit operations. Process design and preparation of process flow chart; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products.
Operation and maintenance of roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plant, sugar mill and other food processing industries

SEC-2203	Commercial Sericulture	0+2

Objective of the Course
- To familiarize the students with entrepreneurial opportunities in commercial sericulture and
- to develop skills among them in production mulberry plants and techniques in scientific rearing of Silkworms.

Practical
1. Planting Material, Planting of Mulberry
2. Maintenance of Mulberry Garden
3. Insect Pests, Diseases and Nutrient Deficiencies of Mulberry
4. Silkworms Rearing House, Rearing Equipment
5. Mulberry Silkworms
6. Non Mulberry Silkworms
7. Mulberry Silkworm Races
8. Dissections of Silk Glands
9. Chawki Rearing of Early Instar
10. Late Age Larval Rearing
11. Pests and Diseases of Silkworm
12. Mounting, Harvesting & Stiffling

SEC-2204	Video Production	0+2

Objective
This course aims to impart working knowledge on the production of educational videos for effective communication

Practical

Need, importance and principles of integrating videos in Agricultural Communication; Stages of video production: storyboard & script writing, sound recording and editing; Equipment for Agricultural video production; Camera handling techniques, lighting techniques, and importance of colours in visual communication; Process of Video editing; using software and smartphones; Uploading videos; Case studies; Production and presentation of Videos.

SEC-2205	Piggery Production Technology	0+2

Objectives:
Develop skills for effective breeding and genetic selection. Formulate pig nutrition programs based on dietary needs. Apply knowledge of swine health management practices. Design and manage appropriate housing for pigs. Understand the economics of pig farming. Implement bio-security measures in pig production systems.

Practical
Overview of pig farming. Key characteristics of pigs: breeds, types, and purposes. Farm visit to observe different pig breeds and farm setup. Selection of breeding stock. Reproductive physiology of pigs. Breeding systems: Natural breeding vs. Artificial Insemination. Demonstration of artificial insemination techniques. Design and construction of pigsties (temperature, ventilation, lighting, and space requirements). Bio-security and disease prevention in housing systems. Design a model of a pigsty, including ventilation and waste management systems. Nutritional requirements of pigs at different growth stages. Types of feeds and feeding systems. Water management. Feed formulation exercise and practical feeding demonstration. Common diseases in pigs and their symptoms. Vaccination and parasite control programs. Veterinary care and medication administration. Health assessment and disease diagnosis simulation; administering vaccines. Stages of growth: Weaning, fattening, finishing. Growth monitoring tools and performance indicators. Hands-on measurement of growth rates and feed conversion efficiency. Farrowing demonstration and piglet care practices. Postnatal management and early piglet nutrition. Creep feeding and transitioning to solid feeds. Weaning exercise and management of piglets post-weaning. Pig slaughtering and carcass evaluation. Quality control standards in pork production. Visit to a slaughterhouse and carcass evaluation. Manure and waste disposal methods. Setting up a small-scale composting or biogas unit. Value addition in piggery products (sausages, bacon, etc.). Case study of a piggery farm's financial performance. Discussion of innovative pig farming practices. Simulated outbreak response and crisis management. Solutions to common challenges in pig farming. Practical Component: Group discussion and presentation on sustainable pig farming.

Suggested Readings

1. Banerjee GC, 2020, A Textbook of Animal Husbandry, Oxford and IBH Publication.
2. ICAR. Handbook of Animal Husbandry. ICAR.
3. Prasad Jagadish, Animal Husbandry and Dairy Science. Kalyani Publishers, New Delhi.
4. Prasad Jagadish, Sheep, Goat and Swine Production. Kalyani Publishers, New Delhi.
5. Sastry, N.S.R. and Thomas, C.K., Livestock Production Management. Kalyani Publishers, New Delhi.

SEC-2206	Goat Production and Management	0+2

Objectives
To provide students with hands-on experience in goat farming practices.
To develop skills in breeding, feeding, health management, and marketing of goats.
To enhance understanding of goat behavior, housing requirements, and farm management.

Practical
Overview of the goat industry: Importance and economic value. Identification of goat breeds. Farm visit to observe different breeds of goats, their characteristics and behavior. Goat breeding systems and selection criteria. Hands-on session on selecting goats based on physical characteristics (conformation, age, health, etc.). Judging for meat, milk, and fiber production. Principles of goat housing and biosecurity measures. Construction and design of goat shelters. Types of goat housing systems (small-scale vs. commercial). Installation of feeding and water systems. Nutritional needs of goats: feed types, supplements, and feeding schedules. Practical feeding of goats based on age, breed, and production stage. Common goat diseases and their management. Vaccination protocols

and deworming. Veterinary intervention and first aid for goats. Reproductive physiology of goats and breeding management techniques. Demonstration of artificial insemination (AI) and natural mating techniques. Pregnancy diagnosis and care of pregnant does. Care of newborn kids. Milk production systems and the dairy goat industry. Milking techniques and handling of milk. Goat meat production systems and processing techniques. Post-slaughter hygiene and processing. Introduction to meat grading and quality standards. Record-keeping for feed intake, growth performance, breeding, health, and production data. Creating a goat farm business plan. Budgeting and cost-benefit analysis of goat farming. Sustainable farming practices in goat production. Implementing sustainable practices on a goat farm. Waste management and composting. Demonstration of a diversified goat farm with crop-livestock integration.

SEC-2207	Seed Production and Testing Technology	0+2

Study of floral biology of monocots and dicots, external and internal structures of monocot and dicot seeds; Preparation of seed album and identification. Seed testing – taking seed samples – germination test, viability test, vigour test, moisture test and conventional purity tests of different crops, Seed treatment–methods of breaking seed dormancy, treatment against systemic disease, seed priming, coating, treatment with beneficial microorganisms. Hand emasculation and pollination in pulses, detasseling in maize, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application; Seed production in different crops – Cereals, pulses, oilseeds and vegetable crops (crops suitable to the season only). Maintaining isolation distance–roguing practices–harvesting, cleaning and packing; Visits to seed production plots and Seed Testing Laboratory; Specifications of tags and labels for different types of seeds; Identification of types of equipment for seed processing and seed testing.

SEC-2208	DUS Testing Technology	0+2

Practical

Introduction to DUS Testing - Importance and regulatory framework (PPV & FRA, UPOV guidelines). DUS Testing Procedures and Protocols -Trial setup, guideline standardization, documentation. DUS Testing of Crops -Focus on Rice, Wheat, Mustard, Chickpea, and Vegetables. Field Preparation and Management - Site selection, sowing, fertilization, irrigation, pest control. Observation and Data Collection Techniques-Techniques for trait recording and use of phenotyping tools. Evaluation of DUS - Assessing distinctness, uniformity, and stability. Data Analysis. Reporting and Documentation - Formatting and submitting comprehensive DUS reports. AI and Modern technological intervention. Quality Assurance - Consistency in testing and troubleshooting. Ethics and Legalities - Farmers' and breeders' rights, ethical considerations.

SEC-2209	Mushroom Production Technology	0+2

Objective

To generate knowledge about edible and cultivated mushroom, their cultivation and entrepreneurship development.

Practical

Mushroom- Definition, history and importance of mushroom cultivation; present scenario of mushroom cultivation in India. Indian knowledge system in mushroom identification, cultivation and their use in human health in ancient time. Types of mushrooms- edible, poisonous, medicinal mushroom; puff balls, truffles and false truffles. food value of mushroom. General morphological features, life cycle pattern of cultivated mushroom. Pure culture of mushroom fungi and their nutritional requirements

Spawn - types, characteristic of a good quality spawn, methods of spawn production, storage of spawn

Cultivation of mushroom - Cultivation different *Agaricus* species (button mushroom)- composting and its formulation, casing, sterilization of casing materials. Cultivation methods, cropping and maintenance, harvesting etc. Different species of oyster mushroom (*Pleurotus* species), substrate selection and cultivation technique. Paddy straw mushroom, its species and their cultivation techniques. Other cultivated mushrooms i.e. *Lentinus*, *Calocybe*, *Auricularia* and *Ganoderma*

Identification and management of different pests and diseases of mushrooms. Post-harvest preservation and value addition of mushroom through indigenous knowledge system. Canning,

pickling, dehydration and value addition of mushrooms. Preparation of different recipes of mushrooms. Economics of mushroom cultivation

Learning Outcome
Student can start their own entrepreneurship by acquiring the knowledge and **s**kills about mushroom cultivation

Multi Disciplinary Courses

MDAGR 01	Fundamentals of Agronomy-I	2+1

Objectives
To impart knowledge on basics of Agronomy – its scope, to understand the role of plant nutrients, importance of tillage and seed, management, modern package of practices in major field crops. Identification of different crops, weeds, tillage implements; fertilizers, seed.

Theory
Introduction: Basic principles of agriculture; Agronomy- definition, scope and importance; Definition and concept of IKS, history, objectives, principles, importance in agricultural crop production.
Tillage and tilth: Definition, objectives, classification of tillage, conservation tillage; Seed and sowing: Definition, characters and classification of seeds; methods of sowing; Crop nutrition: fertility, productivity, definition of manures and fertilizers; classification of manures and fertilizers, bio-fertilizers; importance of bio- fertilizers; Weed: Definition, importance of weed management, classification, methods of weed management; Crop cultivation: wheat, maize, rapeseed and mustard, chickpea, lentil, potato, sesame, jute.

Practical
Identification of crops, seeds, fertilizers, weeds and tillage implements, numerical on plant population and seed rate; numerical on fertilizers and herbicides.

Learning Outcome
Skill development on crop nutrition, tillage, weed management, crop production techniques. Acquainted with different crops, weeds, tillage implements; fertilizers, seed.

MDAGR 02	Fundamentals of Agronomy-II	2+1

Objectives
To impart knowledge on growth, development, crop adaptation, methods and irrigation scheduling; quality of irrigation water and function of macronutrients.

Theory
Growth and development, factors affecting growth and development; plant ideotype; adaptation and distribution of crop; Classification of crops: According to their place of origin, botanical classification, commercial classification, economic classification, seasonal classification, classification according to ontogeny, agronomic classification, classification based on leaf morphology and classification based on serving special purpose; Irrigation: Definition, importance of irrigation, methods of irrigation; irrigation scheduling; quality of irrigation water; harvesting and threshing; Crop rotation and its principles; Crop rotation and mixed farming, principles, importance; protection of crops, nutrient management, post-harvest storage of harvested products through IKS. Function of N, P, K, S, Zn, Fe; Crop cultivation: rice, groundnut, green gram, black gram, sugarcane.

Practical
Identification of crops, seeds, weeds; study of yield contributing characters and yield estimation; measurement of irrigation water; numerical exercises on water requirement.

Learning Outcome
Skill development on water management; harvesting and threshing; crop production techniques.

MDAGR 03	Natural Farming	2+1

Objectives
1. To give students knowledge about natural farming.

2. To teach students the concept, need and principles of native ecology-based production under natural farming
3. To impart practical knowledge of natural farming and related agricultural practices in Indian and global environmental and economic perspectives.

Theory
History of Natural Farming, Importance of natural farming; Definition; Objective of natural farming, Essential characteristics and Principles of natural farming; Scope and importance of natural farming. Main Pillars of natural farming; Methods/ types/ schools of natural farming. Nutrient management in natural farming and their sources, Insect, pest, disease and weed management under natural farming; Processing, labelling, economic considerations and viability, certification and standards in natural farming, marketing and export potential of natural farming produce and products. Initiatives taken by Government (central/state) for promotion of natural farming and chemical free agriculture.

Practical
Visit of natural farm and chemical free traditional farms to study the various components and operations of natural farming principles at the farm; Indigenous technical knowledge (ITK) for seed, tillage, water, nutrient, insect-pest, disease and weed management; On-farm inputs preparation methods and protocols, Studies in green manuring *in-situ* and green leaf manuring, Studies on different types of botanicals and animal urine and dung based non-aerated and aerated inputs for plant growth, nutrient, insect and pest and disease management; Weed management practices in natural farming; Techniques of indigenous seed production, storage and marketing,

Learning Outcomes
Students will be able to understand the basic concept and doable practices of natural farming in reference to changing farming conditions of modern era for environmentally friendly agriculture and will have more opportunities for employment.