



SIXTH DEANS' COMMITTEE REPORT

AGRICULTURAL EDUCATION DIVISION
Indian Council of Agricultural Research
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AGRICULTURE

Course Curricula for Undergraduate programme in Agriculture UG-Certificate in Agriculture UG-Diploma in Agriculture B.Sc. (Hons) Agriculture

INTRODUCTION

Present report is an outcome of the valuable suggestions and recommendations of Sixth Deans' Committee members after having multi-stage in-depth deliberations and discussions in virtual and physical meetings as well as personal communications with the Deans and faculty members of the Agriculture discipline of different SAUs and Central Agricultural Universities, stakeholders from related industries, Government Institutions, alumni and students of the existing course programme across the country.

Restructuring of Undergraduate programme of Agriculture has been carried out as per National Education Policy-2020 guidelines to build among students, a strong foundation of knowledge and increased practical exposure to instil competence and confidence for application of the professional knowledge coupled with hard and soft skills. New scientific advancements in the field of agriculture have been also given due emphasis with inclusion of courses with contents from such areas.

More emphasis has been given on Skill Enhancement Courses, industry attachments, flexibility in choice of courses via electives offered in fourth year and also through online courses along with provision of project work and internship. Provision of UG-Certificate in Agriculture, UG-Diploma in Agriculture and B.Sc. (Hons) Agriculture degree with internship with amalgamation of multiple exit and entry options as per NEP-2020 is important change in the course curriculum.

The detailed report on undergraduate courses of Agriculture viz. UG-certificate in Agriculture, UG-diploma in Agriculture and B.Sc. (Hons) Agriculture has been prepared with due care and inputs of Deans, Heads and faculty members of various departments of agriculture nationwide.

HIGHLIGHTS

- The B. Sc (Hons) Agriculture program will be of 177 credits, which will have 167 credits offered by the parent university and 10 credits of online courses taken by the student as per choice in consultation with university/HAEIs.
- After the admission in the college, the students will register for the Foundation programme of 2 weeks' duration in the 1st semester. A course entitled Deeksharambh (0+2) (Non-gradual) will be offered at the start of first semester for two weeks' duration. This will create a platform for students to learn from each other's life experiences, help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instilling life and social skills, social awareness, ethics and values, team work, leadership, creativity, etc. It will also help in identifying the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario. There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the university academic and research managers.
- The first year of the course program comprises skill development courses along with other fundamental courses of agricultural science. After satisfactory completion of 42 credits of courses in two semesters of 1st year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Agriculture on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the skill development courses, basic courses as well as fundamental courses in agriculture with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural sciences. After satisfactory completion of the courses (84 credits) during first two years and subsequent satisfactory completion of 10 credits (10 weeks) of internship, the student will become eligible for the award of UG-Diploma in Agriculture on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- During the 5th semester, the students will have a study tour of 10-12 days duration, which will be counted as 2 credits (Non-gradual).
- The third- and fourth- year courses have been designed to impart specialized knowledge to the students in the major disciplines. During the 7th semester, the students will adequately select 20 credits from a basket of elective courses, each course being of 4 credits giving an opportunity to them to gain advanced knowledge in frontier areas of agricultural science. The Universities will have flexibility to include more courses as Electives depending on specific needs and situational variations. The objective is to enable the student to acquire deeper understanding in any particular field.
- In the 8th semester of the course the major focus has been on strengthening of the knowledge and skill for developing confidence of the students to take entrepreneurship as their future

career. For this they will undergo an advanced skill enhancement through Student READY: RAWE/ Industrial Attachment /Experiential Learning / Hands-on Training/ Project Work / Internship. A student will select option/s on choice to complete the degree and pursue future career with 20 credits. Each student will be attached to a mentor either from the institution or from an organization/ industry. A university or a college will have the freedom to select the options as referred above.

- The core and elective courses can also be modified maximum up to 30% with approval from competent authority of the University.
- The students will take a minimum of 12 credits of online courses during four years as a partial requirement for the B.Sc. (Hons) Agriculture program. The indicative list of courses has been provided; however, online courses can be from any field such as Agriculture and allied sciences, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, Mook IT, edX, Coursera, SWAYAM or any other such reputed portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradual and separate certificates would be issued by institute/organization offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and indicate the title of the (successfully completed) courses in final transcript issued to the student. A student must submit the list of online courses along with the content he intends to undertake to the Dean/Assoc. Dean/Principal of the college for a permission and records.
- At each stage of exit (UG-certificate/ UG-Diploma and B.Sc. (Hons) Agriculture, the students are expected to acquire competency and confidence to get jobs, to face the real challenges in varied jobs and research, as well as to start their own enterprise. The social skills acquired by the students will also make the students more empathetic towards the society and social issues.
- The credits (and contact hours) have been designed in such a way that along with class room teaching, the students will take up NSS/ NCC and Physical Education, Yoga, etc. in the first year as the case may be. Further a balance has been made by inclusion of common courses, core courses in basic and applied areas, skill development courses, elective courses in advanced areas, online courses of choice, options for entrepreneurship and skill development to pursue future career. This will increase their acquaintance with the social/ technical problems, improve their analytical ability of the issues/ challenges and enhance their social responsibility.

Entry and Exit Options

The entry and exit options for the UG programme in Agriculture are shown in the Fig.-1 below.

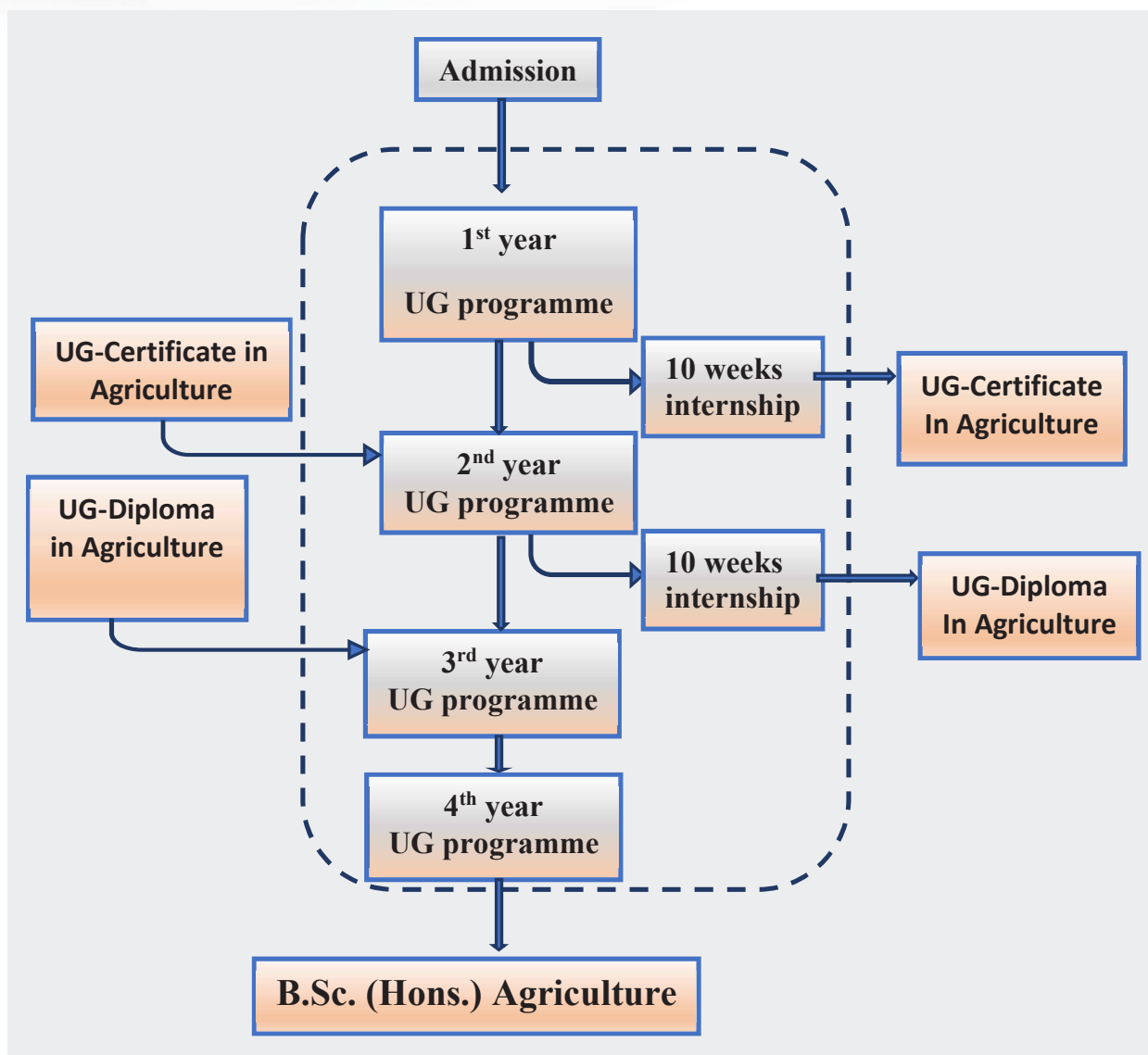


Fig. 1 Entry and Exit options for the UG programme in Agriculture

Exit options

1. **UG-Certificate in Agriculture** (exit after first year and completion of 10 weeks' internship)
2. **UG-Diploma in Agriculture** (exit after second year and completion of 10 weeks' internship)
3. **B.Sc. (Hons) Agriculture** (on successful completion of four-year degree requirements)

Eligibility for Entry into 1st year UG programme: +2 Science with biology as one subject

Provision for multiple exit and entry into the UG programme in agriculture has been made in the light of NEP-2020. A student may exit after completion of 1st year and 2nd year requirements followed by 10 weeks of internship after 1st year and 2nd year, respectively, to get UG-Certificate in Agriculture and UG-Diploma in Agriculture.

The Universities may consider allowing lateral entry for the candidates having Diploma in Agriculture (as such courses are available in many states and lateral entry is practiced in some Universities). In such cases, the candidates having Diploma in Agriculture (with minimum 3 years

course programme after 10th or equivalent) may be allowed admission into the 2nd year of the UG programme, as per the provisions and norms to be notified by the respective AU from time to time.

ACADEMIC PROGRAMME
Semester wise course and credits Allocation

S. No	Course Title	Credit Hours	Total credit hours
First year			
I Semester			
1	Deeksharambh (Induction cum Foundation course)	1 week (NG) Non-gradial	21(11+10)
2	Skill Enhancementcourse-I*	2(0+2)	
3	Skill Enhancementcourse-II*	2(0+2)	
4	Communication Skills	2(1+1)	
5	Farming based livelihood systems	3(2+1)	
6	Rural Sociology and Educational Psychology	2 (2+0)	
7	Fundamentals of Agronomy	3(2+1)	
8	Fundamentals of Soil Science	3(2+1)	
9	Fundamentals of Horticulture	3(2+1)	
10	National Service Scheme (NSS-I)/ National Cadet Corps (NCC-I)	1(0+1)	
11	Introductory mathematics (need based)	1(1+0) Non-gradial	
II Semester			
1	Skill Enhancement course-III*	2(0+2)	21(10+11)
2	Skill Enhancement course-IV*	2(0+2)	
3	Personality Development	2(1+1)	
4	Environmental Studies and Disaster Management	3(2+1)	
5	Soil Fertility Management	3(2+1)	
6	Fundamentals of Entomology	3(2+1)	
7	Livestock and Poultry Management	2(1+1)	
8	Fundamentals of Plant Pathology	3(2+1)	
9	NCC-II/NSS-II	1(0+1)	
Second year			
III Semester			
1	Skill Enhancement course-V*	2(0+2)	21(9+12)
2	Entrepreneurship Development and Business Communication	3 (2+1)	
3	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	
4	Principles of Genetics	3(2+1)	
5	Crop Production Technology-I (Kharif crops)	3(1+2)	
6	Production Technology of Fruit and Plantation Crops	2 (1+1)	
7	Fundamentals of Extension Education	2(1+1)	
8	Fundamentals of Nematology	2(1+1)	
9	Principles and Practices of Natural Farming	2(1+1)	

IV Semester			
1	Skill Enhancement course-VI*	2(0+2)	21(11+10)
2	Agricultural Informatics and Artificial Intelligence	3(2+1)	
3	Production Technology of Vegetables and Spices	2(1+1)	
4	Principles of Agricultural Economics and Farm Management	2(2+0)	
5	Crop Production Technology-II (<i>Rabi</i> Crops)	3(1+2)	
6	Farm Machinery and Power	2 (1+1)	
7	Water Management	2 (1+1)	
8	Problematic Soils and their management	2(1+1)	
9	Basics of Plant Breeding	3(2+1)	
Third year			
V Semester			
1	Agricultural Marketing and Trade	3 (2+1)	22(13+9)
2	Introduction to Agro-meteorology	2(1+1)	
3	Fundamentals of Crop Physiology	3(2+1)	
4	Pest management in Crops and Stored Grains	3 (2+1)	
5	Diseases of Field & Horticultural Crops & their Management	3(2+1)	
6	Crop Improvement (<i>kharif</i> crops) - I	2 (1+1)	
7	Weed Management	2(1+1)	
8	Ornamental Crops, MAPs and Landscaping	2 (1+1)	
9	Introductory Agro forestry	2 (1+1)	
VI Semester			
1	Fundamentals of Agri Biotechnology	3(2+1)	21(12+9)
2	Basic and Applied Agril Statistics	3(2+1)	
3	Crop Improvement (<i>Rabi</i> crops) - II	2(1+1)	
4	Renewable energy in Agriculture and Allied Sector	2(1+1)	
5	Dryland agriculture/ Rainfed agriculture and watershed management	2(1+1)	
6	Agricultural Microbiology and Phyto -remediation	2(1+1)	
7	Agricultural Finance & Cooperation	2(1+1)	
8	Essentials of Plant Biochemistry	3 (2+1)	
9	Fundamentals of Seed Science & Technology	2(1+1)	
Fourth year			
VII Semester			
1	5 Elective Courses (major or minor) each of 4 (3+1) credits for B.Sc. (Hons) Agriculture degree		20(15+5)
VIII Semester			
1	For B.Sc. (Hons)Agriculture Degree Student READY :RAWE/ Industrial Attachment /Experiential Learning / Hands-on Training/ Project Work / Internship		20 Credits
		Total	167
	*Online courses	10	10
		Grand Total	167+10*

* From the bouquet of Skill Enhancement Course (SEC) modules

Department/section wise course breakup

S. No	Course title	Credit Hours	Total
Agronomy			
1	Fundamentals of Agronomy	3 (2+1)	22 (11+11)
2	Farming based livelihood systems	3 (2+1)	
3	Crop Production Technology-I (<i>Kharif</i> Crops)	3 (1+2)	
4	Crop Production Technology-II (<i>Rabi</i> Crops)	3(1+2)	
5	Water Management	2 (1+1)	
6	Weed Management	2 (1+1)	
7	Introductory Agro forestry	2 (1+1)	
8	Dryland agriculture/ Rainfed agriculture and watershed management	2 (1+1)	
9	Principles and Practices of Natural Farming	2 (1+1)	
Soil Science:			
1	Fundamentals of Soil Science	3 (2+1)	8 (5+3)
2	Soil Fertility Management	3 (2+1)	
2	Problematic Soils and their management	2 (1+1)	
Horticulture			
1.	Fundamentals of Horticulture	3 (2+1)	9 (5+4)
2.	Production Technology of Fruit and Plantation Crops	2 (1+1)	
3.	Production Technology of Vegetables and Spices	2 (1+1)	
4.	Ornamental Crops, MAPs, and Landscaping	2 (1+1)	
Genetics and Plant Breeding			
1.	Principles of Genetics	3 (2+1)	12 (7+5)
2.	Basics of Plant Breeding	3 (2+1)	
3.	Crop Improvement (<i>Kharif</i> crops) - I	2 (1+1)	
4.	Crop Improvement (<i>Rabi</i> crops)- II	2 (1+1)	
5.	Fundamentals of Seed Science and Technology	2 (1+1)	
Entomology			
1.	Fundamentals of Entomology	3 (2+1)	6 (4+2)
2.	Pest management in Crops and Stored Grains	3 (2+1)	
Plant Pathology			
1.	Fundamentals of Plant Pathology	3 (2+1)	8 (5+3)
2.	Diseases of Field & Horticultural Crops & their Management	3 (2+1)	
3.	Agricultural Microbiology and Phyto-remediation	2 (1+1)	
Extension Education			
1.	Rural Sociology and Educational Psychology	2 (2+0)	8 (5+3)
2.	Fundamentals of Extension Education	2 (1+1)	
3.	Communication skills	2 (1+1)	
4.	Personality development	2 (1+1)	
Agricultural Meteorology			
1.	Environmental Studies and Disaster mgt.	3 (2+1)	5 (3+2)
2.	Introduction to Agro-meteorology	2 (1+1)	

Agricultural Economics			
1.	Principles of Agricultural Economics and Farm Management	2 (2+0)	9 (6+3)
2	Entrepreneurship Development and Business Communication	3 (2+1)	
3	Agricultural Marketing and Trade	2 (1+1)	
4.	Agricultural Finance & Cooperation	2 (1+1)	
Agricultural Statistics			6 (4+2)
1.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
2.	Basic and Applied Agril Statistics	3 (2+1)	
3.	Introductory Mathematics	1 (1+0)	
Agricultural Engineering			
1.	Farm Machinery and Power	2 (1+1)	4 (2+2)
2.	Renewable energy in Agriculture and Allied Sector	2 (1+1)	
	Nematology		
1.	Fundamentals of Nematology	2 (1+1)	2 (1+1)
	Biochemistry		
1.	Essentials of Plant Biochemistry	3 (2+1)	3 (2+1)
	Crop Physiology		
1.	Fundamentals of Crop Physiology	3 (2+1)	3 (2+1)
	Animal Husbandry		
1.	Livestock and poultry Management	2 (1+1)	2 (1+1)
	Agricultural Bio-technology		
1.	Fundamentals of Agri Biotechnology	3 (2+1)	3 (2+1)
1.	Students' Welfare		1 (0+1)
	NCC/NSS	1 (0+1)	
2.	NCC/NSS	1 (0+1)	1 (0+1)
3.	Physical Education, First Aid and Yoga Practices	2 (0+2)	2 (0+2)
4.	Study Tour	2 (0+2)	2 (0+2)
Non gradial			
*Elective Courses (Indicative)			
1	Agri-Business Management	4 (3+1)	20*(15+5) 5* Elective Courses
2	Management of natural resources	4 (3+1)	
3	Agrochemicals	4 (3+1)	
4	Agricultural Journalism	4 (3+1)	
5	Landscaping	4 (3+1)	
6	Commercial Plant breeding	4 (3+1)	
7	Food safety and standards	4 (3+1)	
8	Bioformulation and Nano formulation	4 (3+1)	
9	Biopesticides and Biofertilizers	4 (3+1)	
10	System Simulation and Agro advisory	4 (3+1)	
11	Hi-tech Horticulture	4 (3+1)	
12	Protected cultivation	4 (3+1)	
13	Climate Resilient Agriculture	4 (3+1)	
14	Biotechnology of Crop Improvement	4 (3+1)	
15	Geoinformatics and Remote Sensing, precision farming	4 (3+1)	
16	Micro-propagation Technologies	4 (3+1)	
17	Commercial Seed Production	4 (3+1)	
18	Principles and Practices of Organic Farming/ Conservation Agriculture	4 (3+1)	
19	Food Science and Nutrition	4 (3+1)	
20	Post-Harvest Technology and Value Addition		
**Skill enhancement courses (SECs)			

1.	SEC-I	2 (0+2)	12 (0+12)
2.	SEC-II	2 (0+2)	
3.	SEC-III	2 (0+2)	
4.	SEC-IV	2 (0+2)	
5.	SEC-V	2 (0+2)	
6.	SEC-VI	2 (0+2)	

*Host institution may add more courses into this list

** SEC will be decided by host institution depending on strength

Summary of credit distributions among different categories of courses (Credit hours)

Semester	Core Courses (Major and Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non gradial	Internship	Online course/ MOOC
I	11	3 ⁽³⁾	---	1 ⁽⁴⁾ +2 ⁽⁵⁾	4		21	2 ⁽¹⁾ +1 ⁽²⁾	----	10⁽¹⁵⁾
II	11	---	3 ⁽⁶⁾	1 ⁽⁴⁾ +2 ⁽⁷⁾	4		21		10 ⁽¹³⁾	
III	14	3 ⁽⁸⁾	---	2 ⁽⁹⁾	2		21		---	
IV	16	---	3 ⁽¹⁰⁾	----	2		21		10 ⁽¹⁴⁾	
V	19	3 ⁽¹¹⁾	----	----	----		22	2 ⁽¹²⁾	----	
VI	21	—	---	---	---		21		---	
VII	20	--	--	---	--		20		--	
VIII		--	--	---	--	20	20			
Total	112	9	6	8	12		167	4	20	10

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).

(2) Remedial Course: Mathematics of 1 credit

(3) Farming based Livelihood systems

(4) NCC/NSS

(5) Communication Skills

(6) Environmental Studies and Disaster management

(7) Personality development

(8) Entrepreneurship Development and Business Management

(9) Physical Education, First Aid and Yoga Practices

(10) Agricultural Informatics and Artificial Intelligence

(11) Agricultural Marketing and Trade

(12) Study tour (10-14 days)

(13) Only for those opting for an exit with UG-Certificate and

(14) Only for those opting for an exit with UG-Diploma

(15) Online course: student will make his own planning and execution of online courses with intimation to the Dean

Summary of Credit Distributions

Type of courses		Credits
Core courses (Major & Minor/s)	:	112
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/SWAYAM	:	10 non-gradial
Total	:	167+10**

List of Courses as per above Categories

Course category	Course title	Credit Hours
Induction cum Foundation course	<i>Deekshaarambh</i>	2 weeks (Non-gradual)
Common courses	Farming based livelihood systems	3 (2+1)
	Communication skill	2 (1+1)
	Personality development	2 (1+1)
	Environmental studies and disaster management	3 (2+1)
	Agricultural Informatics and Artificial Intelligence	3 (2+1)
	Entrepreneurship Development and Business Management	3 (2+1)
	Agricultural Marketing & Trade	3 (2+1)
	NSS/ NCC-I	2 courses each of 1 (0+1) credits
	Physical Education, First Aid and Yoga Practices	2 credits
	Total credits	23
Core Courses	Fundamentals of Agronomy	3 (2+1)
	Crop Production Technology-I (<i>Kharif</i> Crops) including Practical Crop Production	3 (1+2)
	Crop Production Technology-II (<i>Rabi</i> Crops) including Practical Crop Production	3 (1+2)
	Water Management	2 (1+1)
	Weed Management	2 (1+1)
	Introductory Agro forestry	2 (1+1)
	Dryland agriculture/ Rainfed agriculture and watershed management	2 (1+1)
	Principles and Practices of Natural Farming	2 (1+1)
	Fundamentals of Soil Science	3 (2+1)
	Soil Fertility Management	3 (2+1)
	Problematic Soils and their management	2 (1+1)
	Fundamentals of Horticulture	3 (2+1)
	Production Technology of Fruit and Plantation Crops	2 (1+1)
	Production Technology of Vegetables and Spices	2 (1+1)
	Ornamental Crops, MAPs, , and Landscaping	2 (2+1)
	Principles of Genetics	3 (2+1)
	Basics of Plant Breeding	3 (2+1)
	Crop Improvement (<i>kharif</i> crops)- I	2 (1+1)
	Crop Improvement (<i>Rabi</i> crops)- II	2 (1+1)
	Fundamentals of Seed Science Technology	2 (1+1)
	Fundamentals of Entomology	3 (2+1)
	Pest management in Crops and Stored Grains	3 (2+1)
	Fundamentals of Plant Pathology	3 (2+1)

Course category	Course title	Credit Hours
	Diseases of Field & Horticultural Crops & their Management	3 (2+1)
	Agricultural Microbiology and Phyto -remediation	2 (1+1)
	Rural Sociology and Educational Psychology	2 (2+0)
	Fundamentals of Extension Education	2 (1+1)
	Introduction to Agro-meteorology	2 (1+1)
	Principles of Agricultural Economics and Farm Management	2 (2+0)
	Agricultural Finance & Cooperation	2 (1+1)
	Basic and Applied Agril. Statistics	3 (2+1)
	Farm Machinery and Power	2 (1+1)
	Renewable energy in Agriculture and Allied Sector	2 (1+1)
	Fundamentals of Nematology	2 (1+1)
	Essentials of Plant Biochemistry	3 (2+1)
	Fundamentals of Crop Physiology	3 (2+1)
	Livestock and poultry Management	2 (1+1)
	Fundamentals of Agri Biotechnology	3 (2+1)
	TOTAL	92
Elective Courses	20 credits will be taken from list of choice based course list or department wise courses to be decided by host institution	20
	TOTAL	20
Skill Enhancement Courses (indicative)	SDC-I (Biofertilizer and biopesticide production)	2 (0+2)
	SEC-II (Mushroom production technology)	2 (0+2)
	SEC-III (Seed Production Technology)	2 (0+2)
	SEC-IV (Post harvest processing technology)	2 (0+2)
	SEC-V (Beneficial insect farming)	2 (0+2)
	SEC-VI (Horticulture nursery management)	2 (0+2)
	SEC-VII (Plantation crops production and management)	2 (0+2)
	TOTAL	12
Students READY		10+10
	TOTAL	20
Other courses	Remedial course on 1. Mathematics	1 credit Non-gradual
	Study tour (2 weeks in 5 th semester)	2 (0+2) Non-Gradual
	Total for offline course credits	167
Online courses	*Online courses	10
	Grand Total	167+10*

DETAILED SYLLABI

Semester 1

Deeksharambh (Induction-cum-Foundation Course)-Non gradial

1 (1+0)

Objectives

- Help for cultural integration of students from different backgrounds,
- Know about the operational framework of academic process in the University/College/Institute
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.
- Identify strength and weakness of the students in different core areas of the discipline.

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

- i. Discussions on operational framework of academic process in the University, as well as interactions with academic and research managers of the University
- ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- iii. 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
- iv. Activities to enhance cultural Integration of students from different backgrounds.
- 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

Communication Skills

2 (1+1)

Objectives

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 verbal; 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.
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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

Farming based livelihood systems

3 (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 different states, 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, approach, 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, Goatry, Poultry, Duckry 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. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. 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 different agro-climatic zones, 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.

Suggested Readings

1. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar]
2. 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
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. 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, AmitavaDeyUjjwal 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
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.

10. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Rural Sociology and Educational Psychology

2 (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

Fundamentals of Agronomy

3 (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 /un-combined 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, advantages and 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. Agro-climatic 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.

Fundamentals of Soil Science

3 (2+1)

Objective

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

Theory

Soil: Pedological and edaphological 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.

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.

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 Samuel 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.

Fundamentals of Horticulture**3 (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

National Cadet Corps (NCC-1), National Service Scheme (NSS-2)**1 (0+1)**

National Cadet Corps- As per government guidelines, for getting B and C certificate in NCC, minimum years of requirement is 2 and 3 years along with 1-2 annual camps

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.

- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, 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 peace-building. 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

Course Title: Introductory Mathematics (Non-gradual)

1 (1+0)

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 $y = f(x_1, x_2)$.

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

Personality Development

2 (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 Behavior.

Suggested reading

1. Andrews, Sudhir. 1988. How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4. 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. Pravesh Kumar. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadsworth.

Environmental Studies and Disaster Management

3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and 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.

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.

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 un polluted 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 disaster.

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, Prasanthrajan, S., Umesh, M. and Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India. (In Press).
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 - 313 002. First Edition: 2008
6. Prasanthrajan M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

Soil Fertility Management

3 (2+1)

Objective

To provide a comprehensive knowledge of soil fertility, plant nutrition, fertilizers, and nutrient 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 fertilisers, 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).

Practical

Introduction of analytical instruments and their principles, calibration and applications of Colouremetry 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.

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 Samuel 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.

Fundamentals of Entomology

3(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. 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, secretory (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, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae. Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); 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

Livestock and poultry Management

2(1+1)

Objectives

1. Provide basic knowledge to the students about scientific livestock and poultry rearing practices
2. Entrepreneurship development through Livestock/poultry and Agriculture Integrated Farming System

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching 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

Fundamentals of Plant Pathology

3(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, 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. 8th 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.

National Cadet Corps (NCC-II)

1 (0+1)

- Arms Drill-Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.

- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II)

1(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

Entrepreneurship Development and Business Communication

3 (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

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

11. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

Physical Education, First Aid, Yoga Practices and Meditation

2 (0+2)

Objectives

- i) To make the students aware about Physical Education, First Aid and Yoga Practices
- ii) 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 anaerobic 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 Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasana, Vajrasana, Shashankasana, Pashchimotasan, Ushtrasana, Tadasana, Padhasana, Ardha Chandrasana, Bhujangasana, Utanpadasana, Sarvangasana, Parvatasana, Patangasana, Shishupalasana – left leg-right leg, Pavanmuktasana, Halasana, Sarpasana, Ardha Dhanurasana, Sawasana
- Suryanamskara Pranayama (Definition and Importance) Omkar, Suryabhedana, Chandrabhedana, Anulom Viloma, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandha
- Mudras (Definition and Importance) Gyanmudra, Dhyana mudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyana mudra, Uddan mudra
- 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.

Principles of Genetics**3 (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, 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. Probabilit 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, 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. 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

Course Title: Crop Production Technology-I (Kharif crops)**3 (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.

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.

***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.

Production Technology of Fruit and Plantation Crops

2 (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.

Fundamentals of Extension Education

2 (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, DW CRA, 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. Muthaiah Manoraharan, P. and Arunachalam, R., Agricultural Extension, Himalaya Publishing House (Mumbai).
5. Sagar Mondal and Ray, G. L., Text Book on Rural Development, Entrepreneurship and Communication Skills, Kalyani Publications.
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

Fundamentals of Nematology

2(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: 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.

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.

Principles and Practices of Natural Farming

2 (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 of natural farming; Definition of natural farming; 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. 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, Case studies and success stories in natural farming and chemical free traditional farming, 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).

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. Agroecological 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 Telangana), 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. Shamasastri, 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.
25. कमलागतप्रा—ततक—ति: आचार्यदेवव्रत, pp 1-166.

Semester IV

Agricultural Informatics and Artificial Intelligence (AI)

3(2+1)

Objective

- To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
- To provide basic knowledge of computer with applications in Agriculture
- To make students familiar with Agricultural-Informatics, its components and applications in agriculture

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 data base, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction general programming concepts. 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, inputs-outputs 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, post-harvest 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 documents, MS-EXCEL-Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, 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 smartphones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial technology, AR/VR demonstration, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

Production Technology of Vegetables and Spices

2(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

Principles of Agricultural Economics and Farm Management

2(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. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. Laws of returns: Law of variable proportions and law of returns to scale. Cost: 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.

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

Crop Production Technology-II (*Rabi* Crops)

3(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- mentha, lemon grass and citronella. Forage crops –barseem, lucerne and oat; potato, quinoa, tobacco.

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.

- * **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. Chidida 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.

Farm Machinery and Power

2(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 I C engines; comparison of two stroke and four stroke cycle engines, Study of different components of I.C. engine, I.C. engine terminology and solved problems; Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor; Familiarization with Power transmission system : clutch; gear box, differential and final drive of a tractor; Tractor types; Cost analysis of tractor power and attached implement; 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

Water Management

2 (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 both field and horticultural crops and drainage.
3. To study the soil moisture conservation practices including management of rain water, watershed and command areas.

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, sugarcane, mango, banana and tomato); quality of irrigation water, irrigation management practices for different soils and crops, drip, sprinkler. Layout of underground pipeline system, Irrigation automation, Artificial Intelligence and climate-based irrigation practices and its management.

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

3. 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.

Problematic Soils and their management

2 (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.

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.

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, CO_3 , HCO_3 , Cl, SAR and RSC), Determination of nitrate (NO_3^-) from irrigation water, Determination of dissolved oxygen and free carbon dioxide levels in water samples.

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

Basics of Plant Breeding

3 (2+1)

Objectives

To acquaint with different techniques ranging from simply selecting plants with desirable characteristics for propagation, to more complex molecular techniques for breeding new varieties, which are higher yielding, resistant to biotic and abiotic stresses for ensuring food security.

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male-sterility-genetic consequences, cultivar options, Plant genetic resources, its utilization and conservation Domestication, Acclimatization and Introduction. Centres of origin/diversity, Components of Genetic variation. Heritability and genetic advance. Pre-breeding and Universal Plant Breeder's equation. Genetic basis and breeding methods in self-pollinated crops-mass and pure line selection, hybridization techniques and handling of segregating population. Multiline concept, Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross-pollinated crops, modes of selection. Population movement 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. Wide hybridization and pre-breeding. Polyploidy in relation to plant breeding, mutation breeding- methods and uses. Breeding for important biotic and abiotic stresses. Participatory plant breeding. Variety Release and notification. Intellectual Property Rights, Patenting, Plant Breeders and Farmer's Rights.

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.

Suggested Readings

1. Principles of Plant Breeding (1st & 2nd Edition) by RW Allard.
2. Plant Breeding: Principles & Practices by JR Sharma.
3. Plant Breeding- B.D. Singh.
4. Principles and Procedures of Plant Breeding - Biotechnical and Conventional Approaches by GS Chahal and SS Gosal.
5. Principles of Plant Genetics and Breeding by George Acquaah.

Semester V

Agricultural Marketing and Trade

3 (2+1)

Objectives

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 agri-commodities; 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.

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 Joginder Singh. 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.

Introduction to Agro-meteorology

2(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
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, longwave 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 of saturation, 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.

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

Fundamentals of Crop Physiology

3(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 O_2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers; Introduction to C_3 , C_4 and CAM pathways: Calvin Cycle, Hatch and Slack Cycle, CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C_4 plant: Productivity of C_4 plant, CAM: an adaptive mechanism); Factors affecting photosynthesis (light, temperature, CO_2 , O_2 etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Krebs Cycle and ETC, Factors affecting respiration (O_2 , temperature, CO_2 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 Abscissic 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 C_3 and C_4 plants.

Suggested readings

1. Devlin's Exercises in Plant Physiology by Robert Devlin, Francis H. Witham and David F. Blaydes
2. Fundamentals of Plant Physiology by Lincoln Taiz, Eduardo Zeiger, Ian Max Mølle and Angus Murphy
3. Plant Physiology by Robert M. Devlin and Francis H. Witham
4. Plant Physiology by Lincoln Taiz and Eduardo Zeiger
5. Plant physiology by Frank B. Salisbury and Cleon W. Ross

Pest management in crops and stored grains**3 (2+1)****Objectives**

Diagnosis and management of major insect and non- insect pests of crops in field and storage

Theory

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

Diseases of Field and Horticultural Crops and their Management**3 (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 major diseases 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

Crop Improvement (*kharif* crops) – I

2(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 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 conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in maize, rice, sorghum, pearl millet and pigeonpea etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Botany of crops, Floral biology, emasculation and hybridization techniques in different crop species, viz. rice, jute, maize, sorghum, pearl millet, ragi, pigeonpea, urdbean, mungbean, soybean, groundnut, sesame, castor, cotton, cowpea, tobacco, 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.

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

Weed Management

2 (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, factors of competition, factors affecting growth and development. Studies on weed seed bank, 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.

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.

Ornamental Crops, MAPs and Landscaping

2(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

Production technology of ashwagandha, costus, isabgol and geranium; Production technology of mint, aloe and ocimum, Coleus, Glory lily, Periwinkle etc.; Production technology of plants like lemongrass, citronella, vetiver and palmarosa etc., Importance and scope of ornamental crops; Importance and scope of medicinal and aromatic plants and landscaping; Principles of landscaping; Landscape uses of trees, shrubs and climbers, Production technology of important cut flowers like rose, gerbera and orchids; Production technology of gladiolus, tuberose and liliun; Production technology of chrysanthemum and carnation; Package of practices for loose flowers like marigold and jasmine under open conditions; Brief concept of Home landscaping, Carpet bedding, Topiary, Bonsai, Lawn, flower arrangement, Herbaceous Border, Hedge, Edge etc.; Processing and value addition imp ornamental crops; Processing and value addition of MAPs produce.

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.

Introductory Agro forestry**2 (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, field handling 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 forage crops-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 agro-forestry 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

Fundamentals of Agricultural Biotechnology

3(2+1)

Objectives

To familiarize the students with the fundamental principles of biotechnology, various developments in biotechnology and its potential applications

Theory

Introduction to Plant Tissue Culture and Genetic Engineering: History; Cellular totipotency and cytodifferentiation; Callus culture, Single-cell/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; Micropropagation technique for the generation of quality planting material; Synthetic seeds and its applications; National certification and Quality management of TC plants-secondary metabolite production- *in vitro* germplasm conservation.

Introduction to Molecular Biology: DNA structure, structure and function; DNA replication, transcription and translation, RNA, types and function; Structure of prokaryotic and eukaryotic gene; Central dogma of life - DNA replication, transcription, genetic codes-translation and protein synthesis; Lac Operon concept - Nucleic acid hybridization; Polymerase chain reaction- DNA sequencing – Sanger method; PCR and its applications.

Introduction to recombinant DNA technology: DNA modifying enzymes and vectors; plant genetic transformation – physical (Gene gun method), chemical (PEG mediated) and Agrobacterium-mediated gene transfer methods; Transgenic and its importance in crop improvement with successful stories; biosafety. Introduction to various molecular markers: RFLP, RAPD, SSR, SNP etc.; Marker-assisted breeding in crop improvement

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.

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.

Course Title: Basic and Applied Agricultural Statistics

3(2+1)

Objectives To provide an idea on statistical concepts of both descriptive and inference Statistics which will be useful to do statistical analysis

Theory

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.

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. 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-efficients of Dispersions. Co-efficient of Variation.

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.

Probability Theory and Normal Distribution. Introduction to Probability. Basic Terminologies. 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. Normal Distribution- Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve. 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. Tests of Significance. Definition. Null and Alternative Hypothesis. Type I and Type II Error. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample, Two

Sample and Paired t-test with Examples. F-test for Variance. ANOVA and Experimental Designs. Definition of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD). 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.

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 t-test (one sample, two sample independent and dependent). Analysis of variance one-way classification. CRD. Selection of random sample using simple random sampling.

Suggested readings

1. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.
2. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
3. Basic Statistics by B. L. Agarwal, New Age International Publishers.
4. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
5. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
6. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers.

Crop Improvement (*Rabi* crops)- II

2(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 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 conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in wheat, oat, chickpea, rapeseed and mustard etc. Ideotype concept, climate resilient crop varieties 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.

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

Renewable energy in Agriculture and Allied Sector

2(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.

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.

Dryland agriculture/ Rainfed agriculture and watershed management

2(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; Soil and 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 and water conservation techniques; Drought: types, effect of water deficit on physio- morphological characteristics of the plants; Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices; 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. Log 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.

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.

Agricultural Microbiology and Phyto-remediation

2(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. 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 microbiome-residents 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

Agricultural Finance and Cooperation

2(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.

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.

Essentials of Plant Biochemistry

3 (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.

Fundamentals of Seed Science and Technology**2 (1 + 1)****Objectiv Objectives**

1. To impart basic and fundamental knowledge on principles and practices seed science and technology
2. 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, 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.

Semester VII

S. No	Course title	Total credits
1	5 Elective Courses each of 4 (3+1) credits/Research Project with related courses	20
	Total	20

ELECTIVE COURSES

Sl. No	Title
1.	Agri-Business Management
2.	Management of Natural Resources
3.	Agrochemicals
4.	Agricultural Journalism
5.	Landscaping
6.	Commercial Plant Breeding
7.	Food Safety and Standards
8.	Bioformulation and Nanoformulation
9.	Biopesticides and Biofertilizers
10.	System Simulation and Agroadvisory
11.	Hi-tech Horticulture
12.	Protected Cultivation
13.	Climate Resilient Agriculture
14.	Biotechnology of Crop Improvement 3 (2+1)
15.	Geoinformatics and Remote Sensing, Precision Farming
16.	Micro-propagation Technologies
17.	Commercial Seed Production
18.	Principles and Practices of Organic Farming/ Conservation Agriculture
19.	Food Science and Nutrition
20.	Post Harvest Technology and Value Addition

- More electives to be included by the universities / institutions, based on the facilities/ expertise available such as nano fertilizers, robotics, use of drones in agriculture etc

Elective course 1

Agri-Business Management

4 (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, policies procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital management and Financial management of Agribusiness. Financial statements and their importance. Marketing Management: Segmentation, targeting 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.

Elective course 2**Management of natural resources****4 (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.

Elective course 3

Agrochemicals

4 (3+1)

Objectives

To impart knowledge on different classes of agrochemicals

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 organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids, 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 compatibility-preparation 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.

Practical

Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for identification of common fertilizers. Identification of anion and cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available in market. Estimation of nitrogen in Urea. Estimation of water soluble P₂O₅ and citrate soluble P₂O₅ in single super phosphate. Estimation of potassium in Muriate of Potash/ Sulphate of Potash by flame photometer. Determination of copper content in copper oxychloride. Determination of sulphur content in sulphur fungicide.

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.

Elective course 4

Agricultural Journalism

4 (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.

Elective course 5

Landscaping

4 (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. Bio-aesthetic planning: definition, need, planning. Landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions, Bonsai principles and management. Lawn: establishment and maintenance. CAD application.

Practical

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

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.

Elective course 6

Commercial Plant breeding

4 (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 knowledge on seed production, release and notification of varieties and PPV&FR Act, 2001

Theory

Types of crops and modes of plant reproduction. Line development and maintenance breeding in self- and cross- pollinated crops (A/B/R and two-line system) for development of hybrids and seed production. Genetic 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, 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 varieties under PPV and FR Act. Variety testing, release and notification systems in India. Principles and techniques of seed production, types of seeds, quality testing in self- and cross- pollinated crops.

Practical

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

during seed processing, viz. grading and packaging. Visit to public private seed production and processing plants.

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.

Elective course 7

Food safety and standards

4 (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 Hygiene. Food laws and Standards Indian Food Regulatory Regime, FSSAI. Global Scenario CAC. Other laws and standards related to food. Recent concerns -New and Emerging Pathogens. Packaging, Product 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 plans 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 Routledge
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.

Elective course 8

Bioformulation and Nanoformulation

4 (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, Opendar Ed, 2019. Nano-biopesticides Today and Future Perspectives. Academic Press.
12. Shah, M. A. and Tokeer Ahmad. Nano Science and Technology, Wiley India.

Elective course 9

Biopesticides and Biofertilizers

4 (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

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.

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 ectomycorrhiza. 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.

Practical

Isolation and purification of important biopesticides: trichoderma Pseudomonas, Bacillus, Metarhizium etc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides. Isolation and purification of Azospirillum, Azotobacter, Rhizobium, P-solubilizers and cyanobacteria. Mass multiplication and 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.

Elective course 10**System Simulation and Agroadvisory****4 (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.

Elective course 11**Hi-tech Horticulture****4 (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.

Elective course 12

Protected cultivation

3 (2+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, liliun, tulip, tomato, bell pepper, cucumber, strawberry, pot plants etc. Cultivation of economically important medicinal and aromatic plants. Off- season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, Use of portrays in quality planting material production, Bed preparation and planting of crop for production. Inter cultural

operations, Soil EC and pH measurement. Regulation of irrigation and fertilizers through drip, fogging and misting.

Suggested readings

1. Greenhouse operation and management by Paul V. Nelson.
2. Protected cultivation of Horticultural crops by Madan Kr. Jha, Sujana 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.

Elective course 13

Climate Resilient Agriculture

3 (2+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; climate resilient pest-disease management strategies. Breeding strategies for development of climate change resilient crops and varieties, development of biotic and abiotic stress tolerant/resistant cultivars under changed climatic scenarios including extreme weather events.

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, Analysing carbon sequestration potential of different agro-ecosystems; Designing climate smart village model considering the availability of resources. 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.

Elective course 14

Biotechnology of Crop Improvement

3 (2+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.

Elective course 15

Geoinformatics and remote sensing, precision farming

4 (3+1)

Objectives

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

2. o 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 equipments 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.

Elective course 16**Micro-propagation Technologies****4 (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.

Elective course 17**Commercial Seed Production****4 (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 entrepreneurs 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 seed-borne 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.

Elective Course 18

Principles and Practices of Organic Farming and Conservation Agriculture

2 (1+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 in green manuring in-situ and green leaf manuring, Studies on different type 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.

Elective Course 19**Food Science and Nutrition****4 (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, antinutritional 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.

Elective Course 20

Post Harvest Technology and Value Addition

2 (1+1)

Objectives

1. To educate about the different pre-harvest, harvest and post-harvest factors affecting the post-harvest 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.

Semester VIII

S. No	Course title	Total credits
1	For student opting 4 year BSc. (Hons.) degree Student READY (RAWE) / Experiential Learning / Hands on Training / Industrial Attachment / Project Work / Internship etc.	20
	Total	20

SKILL ENHANCEMENT COURSE (SEC)

A student admitted into 1st year of B.Sc. (Hons) Agriculture degree program will take 2 skill enhancement courses each of 2 credits in each semester of first year. Likewise, the student continuing his study into 2nd year of B.Sc. (Hons) Agriculture will undergo 1 skill enhancement course of 2 credits in each of the 2 semesters of 2nd year.

The student can select these courses from a bouquet of skill enhancement courses as indicated below or courses offered by a college. The courses may be offered as module of complementing courses to help the student to achieve skill in a specific area of his interest.

The University/HAEIs may offer such skill enhancement courses in which it has strength/expertise as well as there is prospect of local employment and entrepreneurship development. The courses included in the list are indicative and the University/HAEIs may add more need-based courses in the list depending on their facilities and expertise available.

Indicative skill Enhancement courses

S. No	Course title	Total credits
1	Biofertilizer and biopesticide production	2 (0+2)
2	Production Technology of Bioagents	2 (0+2)
3	Seed Production and Testing Technology	2 (0+2)
4	Mushroom Production Technology	2 (0+2)

S. No	Course title	Total credits
5	Soil, Plant and Water Testing	2 (0+2)
6	Post-harvest Processing Technology	2 (0+2)
7	Beneficial Insect Farming	2 (0+2)
8	Plantation Crop Production and Processing	2 (0+2)
9	Poultry Production Technology	2 (0+2)
10	Piggery Production Technology	2 (0+2)
11	Commercial Horticulture	2 (0+2)
12	Floriculture and Landscaping	2 (0+2)
13	Food Processing	2 (0+2)
14	Agriculture Waste Management	2 (0+2)
15	Organic Production Technology	2 (0+2)
16	Commercial Sericulture	2 (0+2)
17	Video Production	2 (0+2)

ONLINE COURSES

The students will have to take a minimum of 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc. (Hons) Agriculture.

The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The students will take prior approval of the courses they opt from the concerned Dean/Assoc. Dean/Principal of the Faculty/College/Institute.

The courses will be non-gradual as separate certificates would be issued by the Institute/University offering the courses.

However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.