GREEN BOOK

CATALOGUE OF UNDER GRADUATE COURSE

B.Sc. (Hons) Agriculture

as per ICAR Sixth Deans' Committee Recommendations-2024

ANGRAU

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY
Lam, Guntur - 522 034


ADMIN
ACHARYA N.G.RANGA AGRICULTURAL UNIVERSITY
SRI MEKAPATI GOUTHAM REDDY AGRICULTURAL COLLEGE

CATALOGUE OF UNDERGRADUATE COURSE
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(as per ICAR VI Deans Committee Recommendations- 2024)

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FORWARD

Agriculture is the bedrock of human civilization. In India, it remains the heartbeat of rural prosperity and the engine of national growth. Today, however, the sector stands at a critical crossroads. Confronted by the escalating crises of climate change, acute water scarcity, soil degradation, and an exploding global demand for food, traditional farming methods are no longer enough. Safeguarding our future demands a revolutionary paradigm shift. To confront these existential challenges, we need a new vanguard of agricultural pioneers-professionals equipped not just with textbook theories, but with cutting-edge scientific expertise, technological fluency, and an unwavering commitment to sustainability.

The **"Catalogue of Undergraduate Course – B.Sc. (Hons.) Agriculture,"** meticulously re-engineered under the ICAR VI Deans' Committee Recommendations (2024) and aligned with the visionary National Education Policy (NEP) 2020, marks the dawn of this new era. This curriculum shatters the boundaries of conventional learning. By fusing multidisciplinary education with high-impact experiential learning, it transforms students from passive learners into agile problem-solvers, agritech innovators, and dynamic agribusiness entrepreneurs.

Through immersive Rural Agricultural Work Experience (RAWE), rigorous lab research, and hands-on vocational and Skill modules, our students will transcend traditional boundaries to champion climate-resilient practices directly in the field. Congratulations to Dr. Cherukuri Sreenivasa Rao, Dean of Agriculture, and his dedicated team of experts for architecting this transformative blueprint.

To the incoming students embarking on this vital journey from 2024 onward: you are not merely pursuing a degree; you are inheriting a mission to redefine global food security, restore our planet, and uplift society. Welcome to the future of agriculture. Your journey to cultivate change begins now.

(P.V. SATYANARAYANA)

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ANGRAU

PREFACE

Education is the cornerstone for addressing the increasingly complex and evolving challenges facing modern agriculture. In a world profoundly shaped by climate change, resource scarcity, global population growth, and rapid technological transformation, the sector demands professionals who are not only knowledgeable but also innovative, adaptable, and deeply sustainability-driven. Guided by this vision, our faculty is wholeheartedly committed to nurturing graduates who can contribute meaningfully to agricultural advancement, rural prosperity, and environmental stewardship.

Acharya N.G. Ranga Agricultural University (ANGRAU) is dedicated to fostering academic excellence through experiential learning, robust research orientation, and sustainable development. The curriculum has been thoughtfully engineered to build a resilient foundation in agricultural sciences and allied disciplines while sharpening critical thinking, scientific inquiry, and practical problem-solving abilities. By seamlessly integrating rigorous classroom teaching with field-based learning, industry exposure, and skill-oriented training, we aim to prepare graduates capable of addressing real-world agricultural challenges with confidence and competence.

It is with great pride that we present the **"Catalogue of Undergraduate Courses – B.Sc. (Hons.) Agriculture,"** updated in accordance with the ICAR VI Deans' Committee Recommendations (2024). This comprehensive publication is the direct output of dedicated efforts by our faculty and experts to shape a student-centric curriculum aligned with contemporary academic reforms and professional expectations. Emphasizing experiential learning, case studies, and hands-on training, the syllabus ensures a seamless connection between theory and practice. Furthermore, in alignment with NEP 2020, the programme actively champions multidisciplinary learning, innovation, and entrepreneurship.

I sincerely extend my deepest gratitude to the Hon'ble Vice-Chancellor, University Officers, Associate Deans, and all faculty members, research and extension scientists for their invaluable contributions, suggestions and commitment to refining this curriculum. To our students, we extend our heartfelt wishes as you embark on this transformative educational journey-one rooted in responsibility, innovation, and dedicated service toward building a food-secure and sustainable future.

(CHERUKURI SREENIVASA RAO)

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INTRODUCTION

National Education Policy (NEP-2020) was launched by the Government of India for transforming India's education system, seeking reforms at school, college, and university levels to build a knowledge-driven society. National Education Policy (NEP-2020) of India represents a comprehensive and ambitious vision for the future of education in the country.

The NEP-2020 clearly indicates the need for reviving agricultural education which must be aligned with NEP-2020 based on its five pillars, namely, Access, Equity, Quality, Affordability, and Accountability, and to build a competent human resource for undertaking education, research and extension activities at diversified, ecologically sustainable and economically viable agricultural and allied sectors with integration of technology and innovation. The NEP-2020 calls for improvement in both the capacity and quality of agricultural education with the aim to develop good, thoughtful, well-rounded, and creative individuals. This policy also focuses on the study of one or more specialized areas of interest at a deep level, and also on developing character, ethical and constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first century capabilities across a range of disciplines.

As a follow up to the National Education Policy-2020 (NEP 2020), Indian Council of Agricultural Research (ICAR) under the Department of Agricultural Research and Education (DARE), Government of India, as Professional Standards Setting Body (PSSB) of agricultural education for the NEP-2020, set up a high-level committee comprising the Vice Chancellors of Agriculture Universities. It was asked to devise a strategy for implementing NEP-2020 in agricultural education. Soon after the announcement of the NEP-2020, ICAR formulated a committee and developed the guidelines "Implementation strategy for National Education Policy-2020 in Agricultural Education system" and the Sixth Deans' Committee was constituted in 2021, for restructuring the course curricula.

To ensure that agricultural education stays relevant, the ICAR has regularly revised curricula through various Deans' Committees, with five such committees already having updated the academic standards over the years. These revisions align the education system with both national and international standards ensuring students are prepared for the challenges of modern agriculture. ICAR is tasked with the responsibility to aid, impart and coordinate agricultural education to develop high-quality human resources in the country.

The VI Deans' Committee was mandated to revamp the course curriculum, credit framework, and academic standards for agricultural education. This initiative aims to standardize uniform academic structures across the country both in public and private institutions offering undergraduate (UG) programs in agriculture and allied sciences.

Dr. Tej Partap, Chairman of the Sixth Deans' Committee, and committee members put their efforts in aligning agricultural education with NEP-2020 and global trends, under the guidance of Dr. R. C. Agrawal, Deputy Director General (Education), to align, update and contextualise the academic pursuits with NEP-2020 guidelines, and guided by the principles and philosophy of NEP-2020, the committee developed "VI Deans Recommendations", to achieve mission to make agricultural education more accessible, affordable, relevant, practical and professional pursuing national and international quality education standards. The Sixth Deans' Committee,

has prudently with congruence of excellence and relevance revised the undergraduate course curriculum, course contents, degree nomenclature including entry-exit options recommending the reforms in admission including lateral entry options and examinations. The committee had updated the course curriculum as per the guidelines of NEP-2020 focussing skill enhancement with integration of digital learning to align with the evolving global requirements and the advent of new technologies with focus on better employability, flexibility in movement from one institution to another, multiple entry and exit options, choice-based credit system. Experiential leaning and entrepreneurship development programs have been included for training student in real work satiations to develop them as future entrepreneurs. Academic Bank of Credits (ABC) introduced to facilitate movement from one institution to another with credit transfer. Innovative teaching approaches such as online, open distance learning (ODL) and blended learning have been emphasized to merge traditional and non-traditional educational methods. The continuous updating of course curricula based on recent technological advancements ensures that students remain at the cutting edge of agricultural knowledge.

The VI Deans Committee report outlined a restructured course curriculum and credit framework for 13 UG disciplines in agriculture and allied sciences, with necessary provisions in the curriculum to enable an individual to study report major and minor courses along with choice of electives. The 13 UG disciplines of which the course curriculum and credit framework was restructured includes Agriculture, Agricultural Engineering, Biotechnology, Dairy Technology, Fisheries Science, Food Technology, Forestry, Community Science, Horticulture, Food Nutrition and Dietetics, Sericulture with inclusion of two new disciplines namely Natural Farming and Agribusiness anagement.

Key features of the report include curriculum revision, modification of academic structure of degrees/ diplomas/certificates, the introduction of an academic banking system (ABC), a multiple entry-and-exit system, flexible course selection, introduction of skill enhancement courses, making internship as part of UG-certificate, UG-diploma and degree requirements, and the incorporation of industry-oriented internships as part of UG requirements. A course entitled “Deeksharambh” has been introduced in the first semester for a duration of two weeks to acquaint students to learn from each other’s life experiences, traditional values and traditional cultures and values. Common courses have been proposed developing better communication skills and personality development as well as to have a broader view of agriculture and allied sectors. New age courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula for preparing student in the era of Digital Technology. Progressive assessment of the student/s is part of course curriculum and the focus is on enhancing their critical thinking and creativity rather than rote reading.

Highlights of B.Sc (Hons) Agriculture Program

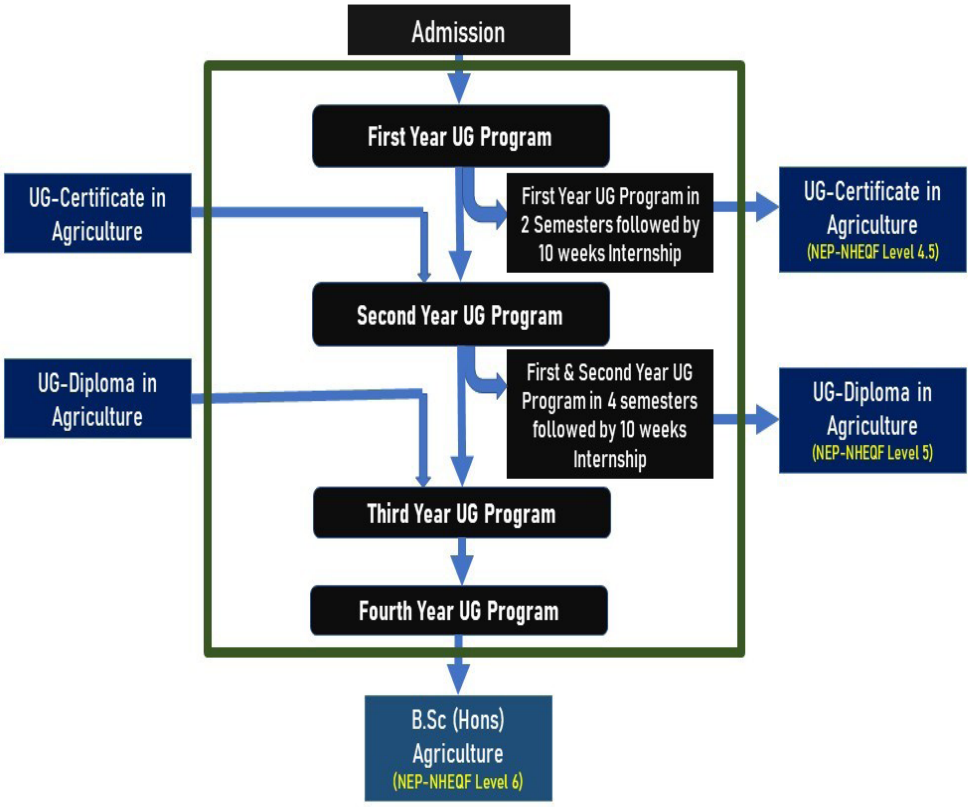
The B. Sc (Hons) Agriculture program will be of 177 credits, which will have 167 credits offered by the parent university and 10 credits of online courses taken by the student as per choice in consultation with university/HAEIs.

- 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-gradial) 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-gradial).
- The third- and fourth- year courses have been designed to impart specialized knowledge to the students in the major disciplines. The students will take a minimum of 10 credits of online courses during V-VII semesters as a partial requirement for the B.Sc. (Hons) Agriculture program. 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-gradial and separate certificates would be issued by institute/organization offering the courses.
- 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.
- 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.



FRAMEWORK OF UNDERGRADUATE PROGRAM IN AGRICULTURE

Adoption and Implementation in ANGRAU

Acharya N. G. Ranga Agricultural University, Andhra Pradesh, is one of the first State Agricultural Universities (SAUs) to study the NEP-2020 and the ICAR VI Deans' Committee Report in detail through a series of meetings and brainstorming sessions on key academic aspects such as course structure, moderation of courses and credits, course outlines, lecture-wise outlines, and allocation of course numbers.

Consequent to preliminary discussions at various levels, the recommendations of the ICAR-Sixth Deans' Committee were deliberated in the Faculty Board of Agriculture meeting held on

07.10.2024, and subsequently in the 113th Academic Council meeting held on 08.10.2024, with respect to the syllabi, course framework, and credit distribution among different categories of courses for the Undergraduate Program in Agriculture. The Sixth Deans' Committee recommendations, with certain modifications as approved by the 113th Academic Council, including courses, course-wise credits, and semester-wise distribution of courses, were implemented in the University from the Academic Year 2024–25. The B. Sc (Hons) Agriculture program in ANGRAU will be of 178 credits (168+10*), which will have 168 credits offered by the University and 10 credits of online courses* taken by the student as per choice in consultation with university/HAEIs.

Subsequently, the lecture-wise outlines of all courses, prepared by teams of faculty under the leadership of the respective University Heads of Department, were deliberated in the Faculty Board Meeting held on 27.12.2024. The course-wise and lecture-wise outlines, along with the implementation details of the Student READY programme, were approved in the 114th Academic Council meeting held on 30.12.2024. Further, detailed discussions on the implementation of the Sixth Deans' Committee Report in accordance with NEP-2020, covering aspects such as Multiple Entry and Exit, the Internship Programme and online courses were conducted during the Faculty Board Meeting held on 01.12.2025. These were subsequently approved, with specific policies for each component, including 10 Days study tour in V Semester in the 116th Academic Council meeting held on 10.12.2025.

SUMMARY OF CREDIT DISTRIBUTIONS AMONG DIFFERENT CATEGORIES OF COURSES AS PER THE MODERATION OF COURSES BY THE ACHARYA N G RANGA AGRICULTRAL UNIVERSITY

Semester	Courses (Major & Minor)	Common Courses			SEC	Internship / Student READY	Total Credits	Non-Gradial	Online Courses / MOOCs
		MDC	VAC	AEC					
I	12	3(2)	-	1(3) + 2(4)	4	-	22	2(1)	-
II	11	-	3(5)	1(3) + 2(6)	4	-	21	-	-
Post-II Semester	-	-	-	-	-	10(12)	-	-	-
III	16	3(7)	-	2(8)	2	-	23	-	-
IV	16	-	3(9)	-	2	-	21	-	-
Post- IV Semester	-	-	-	-	-	10(13)	-	-	-
V	18	3(10)	-	-	-	-	21	2(11)	10
VI	20	-	-	-	-	-	20	-	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	-
TOTAL	113	9	6	8	12	20	168	4	10

MDC	Multi-Disciplinary Course
VAC	Value Added Course
AEC	Ability Enhancement Course
SEC	Skill Enhancement Course
(1)	Deeksharambh (Introduction-cum- Foundation Course) of 2 Credits (2 weeks duration) – Non-Gradial (ICFC)
(2)	Farming Based Livelihood Systems (MDC-100)
(3)	NCC/NSS
(4)	Communication Skills (AEC-191)
(5)	Environmental Studies and Disaster Management
(6)	Personality Development
(7)	Entrepreneurship Development and Business Management
(8)	Physical Education, First Aid, Yoga Practice & Meditation
(9)	Agricultural Informatics and Artificial Intelligence
(10)	Agricultural Marketing and Trade
(11)	Study Tour (10 Days) – Non-Gradial
(12)	Only for those opting for an EXIT with UG-Certificate after II Semester
(13)	Only for those opting for an EXIT with UG-Diploma after IV Semester

SUMMARY OF CREDIT DISTRIBUTION OF VARIOUS COURSES

Type of courses		**Credits**
Core courses (Major & Minors)		93
Common Courses	Multi-Disciplinary Courses (MDC)	9
	Value Added Courses (VAC)	6
	Ability Enhancement Courses (AEC)	8
Skill Enhancement Courses (SEC)		12
Elective Courses		20
Internship / Student READY		20
Online Courses		10*
TOTAL		168 + 10* = 178

SEMESTER WISE CREDITS DISTRIBUTION

Year	**Semester**	**Number of Courses**	**Number of Credits (T+P)**
First (I)	First (I)	10	22 (11+11)
First (I)	Second (II)	9	21 (10+11)
Second (II)	First (I)	10	23 (10+13)
Second (II)	Second (II)	9	21 (11+10)
Third (III)	First (I)	9	21 (12+9)
Third (III)	Second (II)	9	20 (11+9)
Fourth (IV)	First (I)	5 (Elective Courses)	20 (15+5)
Fourth (IV)	Second (II)	Student READY	20
III-I, III-II & IV-I		Online Courses	10*
B.Sc (Hons.) Agriculture UG Program			**168+10* = 178**

SEMESTER WISE COURSES AND CREDITS ALLOCATION

S.No	Course Number	Course Title	Credits (T+P)	Semester
FIRST YEAR – FIRST SEMESTER				
1	ICFC	Deeksharambh - Non-Gradial (Induction cum Foundation course)	2 weeks (0+2)	I-I
2	SEC	Skill Enhancement Course	2(0+2)	I-I
3	SEC	Skill Enhancement Course	2(0+2)	I-I
4	AEC-191	Communication Skills	2(1+1)	I-I
5	MDC-100	Farming based livelihood systems	3(2+1)	I-I
6	AEXT-192	Rural Sociology and Educational Psychology	2(2+0)	I-I
7	AGRO-101	Fundamentals of Agronomy	3(2+1)	I-I
8	SSAC-121	Fundamentals of Soil Science	3(2+1)	I-I
9	ENTO-131	Fundamentals of Entomology	3(2+1)	I-I
10	NCC-I/ NSS-I	National Service Scheme (NSS-I)/ National Cadet Corps (NCC-I)	1(0+1)	I-I
11	STAM-101	Introductory Mathematics	1(0+1)	I-I
		Total Credits	**22 (11+11)**	
FIRST YEAR – SECOND SEMESTER				
12	SEC	Skill Enhancement Course	2(0+2)	I-II
13	SEC	Skill Enhancement Course	2(0+2)	I-II
14	AEC-193	Personality Development	2(1+1)	I-II
15	VAC-161	Environmental Studies and Disaster Management	3(2+1)	I-II
16	SSAC-122	Soil Fertility Management	3(2+1)	I-II
17	HORT-181	Fundamentals of Horticulture	3(2+1)	I-II
18	LSPM-101	Livestock and Poultry Management	2(1+1)	I-II
19	PATH-171	Fundamentals of Plant Pathology	3(2+1)	I-II
20	NCC-II/ NSS-II	National Service Scheme (NSS-II)/ National Cadet Corps (NCC-II)	1(0+1)	I-II
		Total Credits	**21 (10+11)**	
SECOND YEAR – FIRST SEMESTER				
21	SEC	Skill Enhancement course	2(0+2)	II-I
22	MDC-291	Entrepreneurship Development and Business Communication	3 (2+1)	II-I
23	COCA-201	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	II-I
24	GPBR-211	Principles of Genetics	3(2+1)	II-I
25	AGR0-201	Crop Production Technology-I (Kharif crops)	3(1+2)	II-I
26	HORT-281	Production Technology of Fruit and Plantation Crops	2(1+1)	II-I
27	AEXT-292	Fundamentals of Extension Education	2(1+1)	II-I
28	PATH-271	Fundamentals of Nematology	2(1+1)	II-I
29	AGRO-202	Principles and Practices of Natural Farming	2(1+1)	II-I
30	ENTO 231	Insect Ecology & Concepts of Integrated Pest Management	2(1+1)	II-I
		Total Credits	**23 (10+13)**	

SECOND YEAR – SECOND SEMESTER				
31	SEC	Skill Enhancement course	2(0+2)	II-II
32	VAC-202	Agricultural Informatics and Artificial Intelligence	3(2+1)	II-II
33	HORT-282	Production Technology of Vegetables and Spices	2(1+1)	II-II
34	AECO-241	Principles of Agricultural Economics and Farm Management	3(2+1)	II-II
35	AGRO-203	Crop Production Technology-II (Rabi Crops)	2(1+1)	II-II
36	AENG-251	Farm Machinery and Power	2(1+1)	II-II
37	AGRO-204	Water Management	2(1+1)	II-II
38	SSAC-221	Problematic Soils and their management	2(1+1)	II-II
39	GPBR-212	Basics of Plant Breeding	3(2+1)	II-II
		Total Credits	**21 (11+10)**	
THIRD YEAR – FIRST SEMESTER				
40	MDC-341	Agricultural Marketing and Trade	3(2+1)	III-I
41	AGMT-301	Introduction to Agro-meteorology	2(1+1)	III-I
42	CPHY-361	Fundamentals of Crop Physiology	3(2+1)	III-I
43	ENTO-331	Insect Pest management in Field Crops	2(1+1)	III-I
44	PATH-371	Diseases of Field & Horticultural Crops & their Management	3(2+1)	III-I
45	GPBR-311	Crop Improvement (Kharif crops)-I	2(1+1)	III-I
46	AGRO-301	Weed Management	2(1+1)	III-I
47	BICM-301	Essentials of Plant Biochemistry	2(1+1)	III-I
48	AGRO-302	Introductory Agro-forestry	2(1+1)	III-I
49	COCA-301	Study Tour (10-14 days) – Non gradial	2 (0+2)	
		Total Credits	**21 (12+9)**	
THIRD YEAR – SECOND SEMESTER				
50	GPBR-312	Fundamentals of Agri Biotechnology	3(2+1)	III-II
51	STAM-301	Basic and Applied Agricultural Statistics	3(2+1)	III-II
52	GPBR-313	Crop Improvement (Rabi crops)-II	2(1+1)	III-II
53	AENG-351	Renewable energy in Agriculture and Allied Sector	2(1+1)	III-II
54	AGRO-303	Dryland Agriculture and Watershed Management	2(1+1)	III-II
55	PATH-373	Agricultural Microbiology and Phyto-remediation	2(1+1)	III-II
56	AECO-341	Agricultural Finance & Cooperation	2(1+1)	III-II
57	GPBR-314	Fundamentals of Seed Science & Technology	2(1+1)	III-II
58	ENTO-332	Insect Pest Management in Horticultural crops and stored grains	2(1+1)	III-II
		Total Credits	**20 (11+9)**	
FOURTH YEAR – FIRST SEMESTER				
59	ELCT	5 Elective Courses (major or minor) each of 4(3+1) credits	20	IV-I
FOURTH YEAR – SECOND SEMESTER				
60	RAWE/AELP/ Internship/ Project	Student READY: RAWE/ Industrial Attachment/ Experiential Learning / Hands-on Training/ Project Work / Internship	20	IV-II
61	Online Courses	Online Courses during III-I, III-II and IV-I semesters	10*	III-I, III-II & IV-I
		Total Credits for B.Sc. (Hons.) Agriculture Program	**168+10***	

DEPARTMENT WISE COURSES

AGRONOMY & AGRICULTURAL METEOROLOGY

S.No	Course Title	Course Number	Credit Hours (T+P)
1	Fundamentals of Agronomy	AGRO-101	3 (2+1)
2	Crop Production Technology-I (*Kharif* crops)	AGRO-201	3 (1+2)
3	Principles and Practices of Natural Farming	AGRO-202	2 (1+1)
4	Crop Production Technology-II (*Rabi Crops)*	AGRO-203	2 (1+1)
5	Water Management	AGRO-204	2 (1+1)
6	Weed Management	AGRO-301	2 (1+1)
7	Introduction to Agro-Meteorology	AGMT-301	2 (1+1)
8	Introductory Agro-Forestry	AGRO-302	2 (1+1)
9	Dryland Agriculture and Watershed Management	AGRO-303	2 (1+1)
Multi-Disciplinary Courses (MDC)			
10	Farming Based Livelihood Systems	MDC-100	3 (2+1)
Skill Enhancement Courses (SEC)			
11	Agriculture Waste Management	SEC-XIV	2 (0+2)
12	Organic Production Technology	SEC-XV	2 (0+2)
Elective Courses			
13	System Simulation and Agro-Advisory	ELCT-401	4 (3+1)
14	Climate Resilient Agriculture	ELCT-402	4 (3+1)
15	Principles and Practices of Organic Farming and Conservation Agriculture	ELCT-403	4 (3+1)

GENETICS AND PLANT BREEDING

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Principles of Genetics	GPBR-211	3 (2+1)
2	Basics of Plant Breeding	GPBR-212	3 (2+1)
3	Crop Improvement (Kharif crops)-I	GPBR-311	2 (1+1)
4	Fundamentals of Agricultural Biotechnology	GPBR-312	3 (2+1)
5	Crop Improvement (Rabi crops)-II	GPBR-313	2 (1+1)
6	Fundamentals of Seed Science & Technology	GPBR-314	2 (1+1)
Skill Enhancement Courses (SEC)			
7	Seed Production and Testing Technology	SEC-III	2 (0+2)
Elective Courses			
8	Commercial Plant Breeding	ELCT-411	4 (3+1)
9	Biotechnology of Crop Improvement	ELCT-412	4 (3+1)
10	Commercial Seed Production	ELCT-413	4 (3+1)

SOIL SCIENCE

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Fundamentals of Soil Science	SSAC-121	3 (2+1)
2	Soil Fertility Management	SSAC-122	3 (2+1)
3	Problematic Soils and Their Management	SSAC-221	2 (1+1)
Skill Enhancement Courses (SEC)			
4	Soil, Plant and Water Testing	SEC-V	2 (0+2)
Elective Courses			
5	Management of Natural Resources	ELCT-421	4 (3+1)
6	Biopesticides and Biofertilizers	ELCT-423	4 (3+1)
7	Geoinformatics and Remote Sensing, Precision Farming	ELCT-424	4 (3+1)

BIOCHEMISTRY

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Essentials of Plant Biochemistry	BICM-301	2 (1+1)
Elective Courses			
2	Food Safety and Standards	ELCT-422	4 (3+1)
3	Food Science and Nutrition	ELCT-425	4 (3+1)

ENTOMOLOGY

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Fundamentals of Entomology	ENTO-131	3 (2+1)
2	Insect Ecology and Concepts of Integrated Pest Management	ENTO-231	2 (1+1)
3	Insect Pest management in Field Crops	ENTO-331	2 (1+1)
4	Insect Pest Management in Horticultural Crops and Stored Grains	ENTO-332	2 (1+1)
Skill Enhancement Courses (SEC)			
5	Biofertilizers and Plant-Based Biopesticide Production	SEC-I	2 (0+2)
6	Beneficial Insect Farming	SEC-VII	2 (0+2)
7	Commercial Sericulture	SEC-XVI	2 (0+2)
Elective Courses			
8	Bioformulation and Nanoformulation	ELCT-431	4 (3+1)

AGRICULTURAL ECONOMICS

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Principles of Agricultural Economics and Farm Management	AECO-241	3 (2+1)

2	Agricultural Marketing and Trade	MDC-341	2 (1+1)
3	Agricultural Finance & Cooperation	AECO-341	3 (2+1)
Elective Courses			
4	Agri-Business Management	ELCT-441	4 (3+1)

AGRICULTURAL ENGINEERING

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Farm Machinery and Power	AENG-251	2 (1+1)
2	Renewable Energy in Agriculture and Allied Sectors	AENG-351	2 (1+1)
Skill Enhancement Courses (SEC)			
3	Post-Harvest Processing Technology	SEC-V	2 (0+2)
4	Food Processing	SEC-XIII	2 (0+2)
Elective Courses			
5	Soil and Water Conservation Engineering	ELCT-451	4 (3+1)

CROP PHYSIOLOGY

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Environmental Studies and Disaster Management	VAC-161	3(2+1)
2	Fundamentals of Crop Physiology	CPHY-361	3(2+1)
Elective Courses			
3	Micro-Propagation Technologies	ELCT-461	4(3+1)

PLANT PATHOLOGY

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Fundamentals of Plant Pathology	PATH -171	3(2+1)
2	Fundamentals of Nematology	PATH-271	2 (1+1)
3	Diseases of Field and Horticultural Crops and Their Management	PATH-371	3 (2+1)
4	Agricultural Microbiology and Phyto-Remediation	PATH-372	2 (1+1)
Skill Enhancement Courses (SEC)			
5	Production Technology of Bioagents	SEC-II	2 (0+2)
6	Mushroom Production	SEC-IV	2 (0+2)
Elective Courses			
7	Agrochemicals	ELCT-471	4 (3+1)

HORTICULTURE

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Fundamentals of Horticulture	HORT-181	3 (2+1)
2	Production Technology of Fruit and Plantation Crops	HORT-281	2 (1+1)
3	Production Technology of Vegetables and Spices	HORT-282	2 (1+1)
Skill Enhancement Courses			

4	Plantation Crop Production and Processing	SEC-VIII	2 (0+2)
5	Commercial Horticulture	SEC-XI	2 (0+2)
6	Floriculture and Landscaping	SEC-XII	2 (0+2)
Elective Courses			
7	Landscaping	ELCT-481	4 (3+1)
8	Hi-Tech Horticulture	ELCT-482	4 (3+1)
9	Protected Cultivation	ELCT-483	4 (3+1)
10	Post Harvest Technology and Value Addition	ELCT-484	4 (3+1)
11	Ornamental Crops, MAPs & Landscaping	ELCT-485	4 (3+1)

EXTENSION EDUCATION

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Communication Skills	AEC-191	2 (1+1)
2	Rural Sociology and Educational Psychology	AEXT-192	2 (2+0)
3	Personality Development	AEC-193	2 (1+1)
4	Entrepreneurship Development and Business Communication	MDC-291	3 (2+1)
5	Fundamentals of Extension Education	AEXT-292	2 (1+1)
Skill Enhancement Courses (SEC)			
6	Video Production	SEC-XVII	2 (0+2)
Elective Courses			
7	Agricultural Journalism	ELCT-491	4 (3+1)

AGRICULTURAL STATISTICS

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Introductory Mathematics	STAM-101	1(0+1)
2	Agricultural Informatics and Artificial Intelligence	VAC-202	3(2+1)
3	Basic and Applied Agricultural Statistics	STAM-301	3(2+1)

ANIMAL HUSBANDRY

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	Livestock and Poultry Management	LSPM-101	2(1+1)

STUDENTS WELFARE

S.No.	Course Title	Course Number	Credit Hours (T+P)
1	National Service Scheme-I	NSS I	1(0+1)
2	National Service Scheme -II	NSS II	1(0+1)
3	National Cadet Corps -I	NCC I	1(0+1)
4	National Cadet Corps -II	NCC II	1(0+1)
5	Physical Education, First Aid, Yoga Practices and Meditation	COCA-201	2(0+2)
6	Study Tour (10-14 days) -Non gradial	COCA-301	2(0+2)

LIST OF SKILL ENHANCEMENT COURSES (0+2 CREDITS)

S.No	SEC Course Number	SEC Course Title	Lead Department	Supporting Department (s)
1	SEC-I	Biofertilizers and Plant Based Biopesticides	Entomology	Plant Pathology, Soil Science
2	SEC-II	Production Technology of Bio-Agents	Plant Pathology	Entomology
3	SEC-III	Seed Production and Testing Technology	Genetics & Plant Breeding	-
4	SEC-IV	Mushroom Production Technology	Plant Pathology	-
5	SEC-V	Soil, Plant and Water Testing	Soil Science	-
6	SEC-VI	Post-Harvest Processing Technology	Agril Engineering	Horticulture
7	SEC-VII	Beneficial Insect Farming	Entomology	-
8	SEC-VIII	Plantation Crop Production and Processing	Horticulture	-
9	SEC-XI	Commercial Horticulture	Horticulture	-
10	SEC-XII	Floriculture and Landscaping	Horticulture	-
11	SEC-XIII	Food Processing	Agril Engineering	Horticulture
12	SEC-XIV	Agricultural Waste Management	Agronomy	Soil Science
13	SEC-XV	Organic Production Technology	Agronomy	Entomology, Plant Pathology
14	SEC-XVI	Commercial Sericulture	Entomology	-
15	SEC-XVII	Video Production	Extension Education	-

LIST OF ELECTIVE COURSES (3+1 CREDITS)

S.No	Course No	Course Name	Lead Department	Supporting Department (s)
1	ELCT-401	System Simulation and Agro Advisory	Agronomy	-
2	ELCT-402	Climate Resilient Agriculture	Agronomy	-
3	ELCT-403	Principles and Practices of Conservation Agriculture	Agronomy	-
4	ELCT-411	Commercial Plant Breeding	GPBR	-
5	ELCT-412	Biotechnology of Crop Improvement	GPBR	
6	ELCT-413	Commercial Seed Production	GPBR	
7	ELCT-421	Management of Natural Resources	Soil Science	Agril. Engineering
8	ELCT-422	Food Safety and Standards	Biochemistry	Plant Pathology
9	ELCT-423	Biopesticides and Biofertilizers	Soil Science	Plant Pathology & Entomology
10	ELCT-424	Geoinformatics and Remote Sensing, Precision Farming	Soil Science	Agronomy
11	ELCT-425	Food Science and Nutrition	Biochemistry	
12	ELCT-431	Bioformulation and Nanoformulation	Entomology	Plant Pathology & Soil Science
13	ELCT-441	Agri Business Management	Economics	
14	ELCT-451	Soil and Water Conservation Engineering	Agril. Engineering	
15	ELCT-461	Micro-propagation technologies	Crop Physiology	
16	ELCT-471	Agrochemicals	Plant Pathology	Entomology, Soil Science & Agronomy
17	ELCT-481	Landscaping	Horticulture	
18	ELCT-482	Hi-tech Horticulture	Horticulture	
19	ELCT-483	Protected Cultivation	Horticulture	
20	ELCT-484	Post Harvest Technology and Value Addition	Horticulture	
21	ELCT-485	Ornamental crops, MAPs & Landscaping	Horticulture	
22	ELCT-491	Agricultural Journalism	Extension Education	

ABSTRACT OF DEPARTMENT WISE CREDITS OF VARIOUS COURSES

S.No.	Department	Course credits (Theory + Practical)					
		Core (Major & Minor)	SEC	ELCT	MDC	AEC	VAC
1	Agronomy & Agricultural Meteorology	20(10+10)	4 (0+4)	12 (9+3)	4(3+1)	-	-
2	Genetics and Plant Breeding	15 (9+6)	2 (0+2)	12 (9+3)	-	-	-
3	Soil Science	8 (5+3)	2 (0+2)	12 (9+3)	-	-	-
4	Biochemistry	2(1+1)	-	8 (6+2)	-	-	-
5	Entomology	9 (5+4)	6 (0+6)	4 (3+1)	-	-	-
6	Agricultural Economics	5 (3+2)	-	4 (3+1)	3 (2+1)	-	-
7	Agricultural Engineering	4 (2+2)	4 (0+4)	4 (3+1)	-	-	-
8	Crop Physiology	3 (2+1)	-	4 (3+1)	-	-	3 (2+1)
9	Plant Pathology	10 (6+4)	4 (0+4)	4 (3+1)	-	-	-
10	Horticulture	7 (4+3)	6 (0+6)	20 (15+5)	-	-	-
11	Extension Education	4 (3+1)	2 (0+2)	4 (3+1)	3 (2+1)	4 (2+2)	-
12	Agricultural Statistics	4 (2+2)	-		-	-	3 (2+1)
13	Animal Husbandry	2 (1+1)	-	-	-	-	-
14	Students Welfare	-	-	-	-	5 (0+5)	-

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AGRO 101
FUNDAMENTALS OF AGRONOMY
3 (2+1)

Objectives

To impart the basic and fundamental knowledge of Agronomy.

Course Outlines

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: plantgeometry 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: 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, Concept of water availability to plants, soilplant - Water relationship, crop water requirement, water use efficiency, Methods of irrigation : Scheduling of irrigation, different approaches of scheduling irrigation.

Weeds: Definition, Importance and basics of classification of weeds and their control. Agro-climate 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 ofinter 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, Measurement of soil moisture by

gravimetric and volumetric method and bulk density, Determination of field capacity, Determination of gross and net irrigation requirement, Determination of infiltration rate.

Lecture Outlines

Theory

1. Agronomy - Definition, meaning and scope - Art, science and business of crop production - Agronomy in relation with other disciplines of Agricultural Sciences.
2. Agro-climatic zones of India and Andhra Pradesh.
3. Crops - Classification of crops - Field crops- Cereals, Millets, Pulses, Oil seeds, Commercial crops - Scientific names - Economic importance.
4. Tillage and tilth - Objectives of tillage- Characteristics of ideal seed bed - Effect of tillage on soil properties.
5. Types of tillage, advantages and disadvantages - Factors affecting tillage and seed bed preparation - Puddling - After cultivation.
6. Modern concepts of tillage - Minimum tillage, zero tillage, strip tillage, conservation tillage and their advantages and limitations.
7. Seeds and sowing - Variety - Characteristics of good quality seed, Seed treatment - Agronomic significance of seed purity and quality.
8. Methods of sowing- Broadcasting, drilling, dibbling and transplanting.
9. Crop stand establishment - Factors affecting crop stand establishment.
10. Growth and development of crops - Definition - Meaning and factors affecting growth and development.
11. Crop density and geometry - Planting geometry- Optimum plant density and planting pattern. Plant population - Competition - Types of competition - Inter and intra plant competition - Effect of plant population on growth and yield.
12. Cropping pattern, Cropping system- Crop rotation - Principles of crop rotation - Mono cropping and its disadvantages - Types of cropping systems - Mixed cropping, intercropping, multiple cropping, relay and multi storied cropping.
13. Cropping systems- Factors affecting cropping systems - Major cropping patterns and systems in India and Andhra Pradesh.
14. Soil fertility and soil productivity - Soil organic matter and its importance - Loss of soil fertility and its maintenance.
15. Crop Nutrition - Definition of essential nutrients - Criteria of essentiality, functional elements - Classification of essential nutrients - Role of macro and micro nutrients.
16. Manures and fertilizers - Source of nutrients - Organic manures and bio-fertilizers, their classification and characteristics - Role of organic manures in crop production.
17. Inorganic fertilizers - Classification - Methods of fertilizer application -Integrated nutrient management (INM)- Components and advantages of INM - Nutrient use efficiency.
18. Green manures - Role in crop production - Definition, objectives of green manuring - Desirable characteristics of green manure crops - Advantages and limitations of green manures.
19. Dry farming, dryland farming and rainfed farming - Problems of crop production in dry areas - Length of crop growing period.
20. Soil and moisture conservation - Water harvesting techniques (in-situ and ex-situ) - Watershed - definition - Objectives.
21. Irrigation- Importance and objectives of irrigation - Water resources of the World,

India and Andhra Pradesh.

22. Soil moisture constants - FC, PWP and hygroscopic coefficient- Kinds of water-gravitational water, capillary water and hygroscopic water - Crop water requirement - Moisture sensitive stages.
23. Methods of Irrigation - Surface methods - Micro irrigation - Drip and sprinkler methods - Advantages and limitations.
24. Weed- Definition - Importance - Harmful and beneficial effects of weeds- Classification of weeds.
25. Crop weed competition - Critical period for crop weed competition - Allelopathy-meaning and its importance in weed management.
26. Weed management principles - Prevention, control and eradication.
27. Weed Management - Physical, mechanical, cultural, biological and chemical methods - Integrated weed management (IWM).
28. Herbicides - Definition - Classification of herbicides based on selectivity, time and method of appli- cation- Advantages and limitations of herbicides.
29. Sustainable crop production - Definition - Importance - Principles and practices - Natural resources and conservation.
30. Harvesting and threshing of crops - Maturity symptoms of major crops (Rice, Maize, Redgram, Blackgram, Bengalgram, Groundnut, Sunflower, Sesame and Sugarcane).
31. Methods of harvesting - Threshing and winnowing, drying and post harvest storage of grains-Harvest index and BC ratio.
32. Weather- Climate- Differences between weather and climate - Different weather parameters - Weather forecasting- Types of Weather forecasting.

Praticals

1. Visit to College farm and study of major crops and varieties.
2. Identification of crops, seeds and fertilizers.
3. Study of Primary tillage implements.
4. Study of Secondary tillage implements.
5. Study of seeding equipment and inter cultivation implements.
6. Practice of ploughing and puddling.
7. Seed germination and viability test.
8. Calculation of Plant Population and Seed rate.
9. Calculation of fertilizer requirement.
10. Study of yield attributes in different crops.
11. Estimation of yield in different crops.
12. Practice on method of application of manures and fertilizers.
13. Study of micro irrigation methods.
14. Identification of maturity symptoms of different crops.
15. Identification of weeds in field crops and other habitats.
16. Herbicide label information, computation of herbicide doses and precautionary measures while using herbicides.

Suggested readings:

1. William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
2. Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
3. Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.

4. Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.
5. Reddy, S. R. 2008. Principle of Crop Production, Kalyani Publisher, Ludhiana

AGRO 201
CROP PRODUCTION TECHNOLOGY -1 (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.

Course Outlines

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.

Practicals

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

Lecture Outlines

Theory

1. Cereals - Importance - Rice - Origin - Geographical distribution - Nutritional Value - Area, Production and productivity in India and Andhra Pradesh. Economic importance - Classification of rice plant types.
2. Soil and climatic requirements - Different types of rice ecosystems - Field preparation - crop establishment techniques in rice.
3. Nutrient Management - Water management.
4. Weed management - Harvesting- Yield attributes- Yield - Post harvest operations - Cropping systems in rice - Values added products.
5. Maize - Origin - Geographical distribution - Economic importance - Area production and productivity in India and A.P - Soil and climatic requirement - Classification of maize.
6. Maize - Field preparation - Seeds and sowing - Nutrient management - water management - weed management - Harvesting - Yield attributes - Yield - Value addition - Zero tillage maize - Cropping systems.
7. Sorghum, Pearl millet - Origin - Geographical distribution - Economic importance - Area production and productivity in India and AP - Soil and climatic requirement -

Field preparation - Seeds and sowing- Nutrient management - Water management - Weed management - Harvesting - Yield attributes - Yield - Value addition - Cropping systems.

8. Finger millet and other minor millets (Foxtail millet, Kodomillet, Prosomillet, Little millet) - Origin - Geographical distribution - Economic importance - Adaptations - Soil and climatic requirement - Field preparation - Seeds and sowing - Nutrient management - Water management - Weed management - Harvesting - Yield attributes - Yield - Value addition - Cropping systems.
9. Pulses - Economic importance Constraints for achieving higher productivity of pulses - Strategies for improving the pulse production in India - Rice fallow pulses - Greengram, Blackgram - Origin - Geographical distribution - Economic importance - Area production and productivity in India and AP - Soil and Climatic requirement, Field preparation - Seeds and sowing - Nutrient management - Water management- Weed management - Harvesting - Yield attributes - Yield - Cropping systems.
10. Pigeon pea - Origin - Geographical distribution - Economic importance - Area production and productivity in India and AP - Soil and climatic requirement, Field preparation - Seeds and sowing - Nutrient management - Water management - Weed management - Harvesting - Yield attributes - Yield - Cropping systems.
11. Groundnut, Soya bean - Origin - Geographical distribution - Economic importance - Area production and productivity in India and AP - Soil and climatic requirement - Field preparation - Seeds and sowing - Nutrient management - Water management - Weed management - Harvesting - Yield attributes - Yield - Quality parameters - Cropping systems.
12. Sesame, Castor - Origin - Geographical distribution - Economic importance - Area, production and productivity in India and AP - Soil and climatic requirement, Field preparation - Seeds and sowing - Nutrient management - Water management - Weed management - Harvesting - Yield attributes - Yield - Quality parameters - Cropping systems.
13. Cotton - Origin - Geographical distribution - Economic importance - Area production and productivity in India and AP - Classification - Soil and climatic requirement - Field preparation - Seeds and sowing - Varieties/Bt. Cotton - Branching - Nutrient management - Water management - Weed management - Topping - Bud and boll shedding - Harvesting - Defoliants - Mechanized harvesting - Yield attributes- Yield - Quality parameters - Cropping systems.
14. Jute, Mesta, Sunhemp - Origin - Geographical distribution - Economic importance - Area production and productivity in India and AP - Classification - Soil and climatic requirement- Land preparation - Seeds and sowing - Nutrient management - Water management - Weed management - Yield attributes - Yield - Harvesting - Retting - Quality parameters - Cropping systems.
15. Forage Crops - Importance - Terminology in forage production - Classification of fodders - Quality parameters - Sorghum - Maize - Importance - Seeds and sowing - Nutrient management - Irrigation - Weed management - Harvesting - Yield - Quality of fodder.
16. Cowpea - Cluster bean - Guinea grass and napier grass - Importance, seeds and sowing - Nutrient management, irrigation - Weed management - Harvesting - Yield - Quality of fodder.

Practicals

1. Identification of seeds/Crops.
2. Land preparation, layout of plots and calculation of seed rate.
3. Sowing of crops in student plots.
4. Raising of rice nursery including SRI nursery.
5. Study of the effect of seed size on germination and seedling vigor.
6. Effect of sowing depth on germination of Kharif crops.
7. Identification of major weeds in different crops.
8. Practicing of Puddling - Transplanting of rice to main field.
9. Calculation of fertilizer dose - Fertilizer application - Top dressing and foliar feeding of nutrients.
10. Scheduling of irrigation to the crops.
11. Visit to the research station of related crops.
12. Agronomic characters of Cereal crop varieties.
13. Agronomic characters of Millet crop varieties.
14. Agronomic characters of Pulse crop varieties.
15. Agronomic characters of Oil seed crop varieties.
16. Agronomic characters of Fibre crop varieties.
17. Agronomic characters of Forage crop varieties.
18. Recording of Biometric observations in student plots.
19. Morphological description and growth stages of cereal crops.
20. Morphological description and growth stages of millet crops.
21. Morphological description and growth stages of pulse crops.
22. Morphological description and growth stages of oilseed crops.
23. Morphological description and growth stages of fibre crops.
24. Morphological description and growth stages of forage crops.
25. Recording of yield attributes and estimation of yield in different crops.
26. Harvesting and recording of yield.
27. Post harvest operations and mechanization in different crops.
28. Harvesting of forage crops and recording of yield.
29. Hay and silage making.
30. Visit to agronomic experiments at experimental farms.
31. Visit to farmer's fields.
32. Visit to post harvest processing units.

Suggested readings

1. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd.,New Delhi.
2. Gurarajan B., Balasubramanian R. and Swaminathan V. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
3. Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
4. Reddy S.R. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
5. Singh S.S. 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.

AGRO 202
PRINCIPLES AND PRACTICES OF NATURAL FARMING
2 (1+1)

Objectives

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

Course Outlines

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.

Practicals

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; Evaluation of ecosystem services in natural farming (Crop, Field and System).

Lecture Outlines

Theory

1. AGRO - Indian Heritage of Ancient Agriculture, History of Natural Farming, Importance of natural farming in the present context, Natural farming: Definition

- Concept - Objective - Principles of Natural farming. Status of Natural farming in World and India.

2. AGRO - Scope and importance of natural farming - Main pillars of natural farming- Methods/ types/schools of natural farming. Characteristics of a natural farm. Merits and limitations of Natural farming - Types of natural farming systems and practices (Bio-dynamic, Homa farming, Natueco farming, Rishi Krishi, Panchagavya Krishi, Yogic farming).
3. AGRO - Soil health, Water use - Biodiversity conservation - Food and Nutritional security - Sustainable Development Goals (SDGs). Concept of ecological balance - Ecological engineering and community responsibility in natural versus other farming systems.
4. AGRO - Introduction to concept of ecological water, carbon and nitrogen foot prints, carbon sequestration- Concept and evaluation of ecosystem services.
5. AGRO - Integration of crops with trees and animals, cropping system approaches - Rearing of animals (Dairy, sheep and goat) under natural farming.
6. AGRO - Indigenous seed production - Farm waste recycling - Use of renewable energy approaches in a natural farm - Water conservation - Nutrient management in natural farming.
7. AGRO - Weed management under natural farming and mechanization in natural farming.
8. AGRO - Important natural farming practices for field crops Natural farming in India - Key policies, Programmes - Challenges in growth of natural farming in India.
9. ENTO - General practices in natural farming to contain insect pests on various field crops - Pest definition- categories of different pests - Farmers Field School- Ecological engineering concepts, principles and approaches - Biodiversity in eco-friendly agriculture.
10. ENTO - Study of Indigenous technical Knowledge for insect pests and disease management in natural farming- Preparation and use of panchagavya, vermi wash, sour butter milk, Ghana jeevaamrutham, beejamrutham, drava jeevaamrutam and application to combat insect pests and diseases on various crops.
11. ENTO - Study of IPM - Concepts, Principles and different principles in pest management in natural farming – Pest surveillance and pest forecasting - Seed treatment - Host plant varietal selection - Agronomic management practices - Crop rotation - Intercrops - Trap crops- Cover crops - Physical and mechanical measures- Role of Pheromone traps and different types pheromones traps used in pest monitoring - ITKs related to management of plant diseases - Suppressive soils, concept and potentialities for managing soil borne pathogens.
12. ENTO-Study of Insecticidal properties of botanical insecticides - Neem, Pongamia, custard apple, Vitex nigundo, sweet flag- Preparation of different plant based oils and extracts - Neem oil, eucalyptus, NSKE , PSKE, Custard leaf extract – Tobacco decoction- Chilli and garlic paste- Role of soil microbiome in disease management.
13. ENTO-Study and preparation of Neemastra, Agniastra, Brahmastra, vavilaku, Ipomia, datura kashayam and Dasapatra kashayam - Usage and Precautions - Field application against insect pests and diseases. Role of cultural/physical /mechanical/Indigenous techniques in management of different stored grain insect pests- Different traditional storage structures used to minimize insect damage on different stored grains and products.

14. AGRO - Processing, labelling, Certification and standards in natural farming.
15. AECO - Marketing and export potential of natural farming produce and products - Economic viability (Yield, Cost of production, Net Income) of natural farming products.
16. AECO - 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.

Practicals

1. AGRO - Visit of natural farm and chemical free traditional farms to study the various components and operations of natural farming.
2. AGRO - Indigenous technical knowledge (ITK) for seed, tillage, water, nutrient, insect-pest, disease and weed management.
3. AGRO - On-farm inputs - Preparation methods and protocols. (botanicals and animal urine and dung based non-aerated and aerated inputs for plant growth, nutrient).
4. AGRO - Weed management practices in natural farming (cultural practices - Stale seed bed- Mulching, smothering crops).
5. ENTO - Study of Agro ecosystem analysis (AESA) - Principles and methodology for Assessment of insect pests and diseases under natural farming.
6. ENTO - Study of methods and Preparation of Panchagavya, Sour Butter Milk, Ghana Jeevaamrutham, Beejamrutham, Drava Jeevaamrutam for insect pests and disease management.
7. ENTO - Study of preparation of different cow products based plant extarcts Neematra, Agniastra, Brahmastra etc. for insect pests and disease management.
8. ENTO - Mass production and field release of important insect predators, parasitoids and Entomopathogenic fungi.
9. AGRO - Techniques of indigenous seed production - Storage and marketing.
10. AGRO - Partial and complete nutrient and financial budgeting in natural farming.
11. AGRO - Evaluation of ecosystem services in natural farming (Crop and System).
12. AGRO - Economic analysis of natural farming systems.
13. PATH - Visit to bio control laboratory and study of preparation of biofertilizers/ bio-inoculants.
14. AGRO - Studies on post-harvest handling of natural farming products.
15. AGRO - Study of quality parameters of natural farming produce (shelf-life, colour, flavour, aroma, taste).
16. AGRO - Visit to natural farming fields and documentation of the natural farming practices.

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. Behera U.K. 2013. A text Book of Farming System. Agrotech Publishing House, Udaipur.
3. Boeringa, R. (Eed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199 pp.
4. 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.
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. HLPE. 2019. Agro ecological 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.
11. 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.
12. Malhotra R. and S.D. Babaji. 2020. Sanskrit Non Translatable- The importance of Sanskritizing English. Amaryllis, New Delhi India.
13. Nalini, S. 1996. Vrikshayurveda (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telengana), India. 94pp.
14. Nalini, S. 1999. Krishi-Parashara (Agriculture by Parashara) by Parashara. Brig Sayeed Road, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
15. 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.
16. Natural Asset Farming: Creating Productive and Biodiverse Farms by David B. Lindenmayer, SuzannahM. Macbeth, et al. (2022).
17. Natural Farming Techniques: Farming without tilling by Prathapan Paramu (2021).
18. Plenty for All: Natural Farming A to Z Prayog Pariwar Methodology by Prof. Shripad A. Dabholkar and Prayog Pariwar Prayog Pariwar (2021).
19. 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.
20. Shamasastry, R. 1915. Kautilya's Arthashastra. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016).

AGRO 203
CROP PRODUCTION TECHNOLOGY–II (RABI CROPS)
2 (1+1)

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.

Course Outlines

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, rajmash, Oilseeds - Rapeseed, mustard, sunflower, safflower and linseed; Sugar crops-sugarcane and sugarbeat; Medicinal and aromatic crops- mentha, lemon grassand citronella, Forage crops –berseem, lucerne and oat, potato, quinoa and 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.

Lecture Outlines

Theory

Rabi Cereals

1. Wheat - Origin - Geographical distribution - Area, production and productivity in major wheat growing states in India - Economic importance - Soil and climatic requirements - Growth stages – Classification.
2. Field Preparation - Seeds and sowing - Nutrient management - Water management - Weed management- Harvesting - Yield attributes - Yield - Wheat based cropping systems.
3. Barley and Quinoa - Origin- geographical distribution - Economic importance - Classification - area, production and productivity in major barley growing states in India - Soil and climatic requirements - Varieties - Cultural practices - Harvesting - Yield attributes - Yield

Rabi Pulses

4. Chickpea - Origin - Geographical distribution- Economic importance - Area, production and productivity in India and Andhra Pradesh - Types of chick pea - Soil and climatic requirements - Growth stages - Field preparation - Seeds and sowing - Varieties- Nutrient management- Water management- Weed management- Harvesting - Yield attributes - Yield.
5. Rabi Redgram and Rajma - Origin - Geographical distribution - Economic importance- area, production and productivity in India and Andhra Pradesh - Soil and climatic requirements - Growth stages - Field Preparation - Seeds and sowing - Varieties - Nutrient management - Water management - Weed management - Harvesting- Yield attributes - Yield.

Oilseeds

6. Rapeseed and mustard - Origin - Classification- Geographical distribution - Area, production and productivity in major rapeseed and mustard growing states in India - Economic importance- soil and climatic requirements- Field preparation - Seeds and sowing - Varieties- Nutrient management - Water management - Weed management- Harvesting - Yield attributes - Yield - quality considerations.
7. Sunflower and Safflower - Origin - Geographical distribution - Area, production and productivity in India and Andhra Pradesh - Economic importance- Soil and climatic requirements- Field preparation - Varieties - Seeds and sowing- Nutrient management- Water management- Weed management - Seed setting problems and measures in sunflower - Harvesting- Yield attributes-Yield.
8. Linseed and Niger - Origin - Geographical distribution - Area, production and productivity in India and Andhra Pradesh - Economic importance - soil and climatic requirements - Field preparation - Seeds and sowing- Season - Pyra/utera (Linseed) - Varieties - Nutrient management - Water management - Weed management - Harvesting - Yield attributes - Yield quality considerations.

Sugar Crops

9. Sugarcane - Origin - Geographical distribution - Area, production and productivity in India and Andhra Pradesh - Economic importance - Soil - Climatic requirements - Influence of rainfall, temperature, light - Growth stages- Field preparation - Planting time in Coastal and Rayalseema regions of AP, Planting material - Setts - Short crop - Nursery crop - Different methods of planting.
10. Nutrient Management - Trash mulching - Wrapping and propping - Water management- Weed management - Criteria for judging maturity - Ratoon cane management - Factors affecting quality of sugarcane - Arrowing - Crop logging.
11. Sugarbeet - Origin - Geographical distribution - Area, production and productivity in India - economic importance - Soil - Climatic requirements - Field preparation - Seeds and sowing - Nutrient management - Water management - weed management- Harvesting- Yield attributes - Yield.

Forage Crops

12. Berseem, Lucerne, Oat - Importance - Seeds and sowing - Nutrient requirement- Irrigation - Weed management- Harvesting - Yield quality of fodder.

Medicinal and aromatic Crops

13. Mentha, Lemon grass, Citronella- Origin - Geographical distribution - Area, production and productivity in major Mentha, Lemon grass, Citronella growing states in India - Economic importance- Soil - Climatic requirements Field preparation - Seeds and sowing- Nutrient management - Water management- Weed management- Harvesting- Yield attributes – Yield.

Other Crops

14. Potato - Origin - Geographical distribution - Area, production and productivity in India - Economic importance - Soil - Climatic requirements - Varieties - Field preparation - Seeds and sowing- Nutrient management - Water management - Weed management- Harvesting- Yield attributes-Yield - Quality considerations.
15. Tobacco - Origin - Geographical distribution - Area, production and productivity in India and Andhra Pradesh - Economic importance - Soil - Climatic requirements – Types of tobacco - Field preparation, Nursery management - Seeds and sowing for different types- Seed treatment- Seed rate- Spacing - Season - Time and method of sowing.

16. Tobacco-nutrient management - Topping and desuckering - Water management- Weed management- Harvesting - Yield attributes - Yield - Priming - Curing, Quality characters - Nicotine content, burning quality, aroma and sugar content - Methods of curing - Flue curing of Virginia tobacco.

Practicals

1. Land preparation and layout of plots
2. Sowing methods of wheat
3. Planting methods of sugarcane
4. Sowing and raising of rabi oil seeds and fodder crops
5. Sowing and raising of rabi pulse crops
6. Identification of weeds in rabi season crops
7. Study of growth parameters and yield attributes (biometric observations) of rabi oil seed crops
8. Study of growth parameters and yield attributes (biometric observations) of rabi pulse crops
9. Visit to nearby Agro-based industry
10. Study of important agronomic experiments of rabi crops at research farms
11. Visit to Forage crops
12. Visit to Jaggery making units
13. Hay and silage making
14. Raising of tobacco nursery
15. Study of quality parameters of tobacco
16. Visit to nearby pulse and oil processing units related to rabi crops

Suggested readings

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

AGRO 204
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

Course Outlines

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); Agricultural drainage. Water management problem, 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 and weirs; Calculation of irrigation water requirement (Problems); Determination of infiltration rate; Demonstration of furrow method of irrigation; Demonstration of check basin and basin method of irrigation; 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; Determination of EC, pH, carbonates, bio-carbonates, Ca++ and Mg++ in irrigation water (quality parameters). Visit to irrigation research centre/ station and visit to command area.

Lecture Outlines

Theory

1. Irrigation - Introduction, importance, definition and objectives - Water resources of world.
2. Surface and ground water resources in India and Andhra Pradesh - Important

major irrigation projects in India and Andhra Pradesh - Irrigation development over years for different crops in India

3. Soil- Water relations - Physical properties of soil viz., depth, soil texture, soil structure, particle density, bulk density and porosity influencing water retention, movement and availability.
4. Water retention in soil - Adhesion and cohesion - Soil moisture tension - pF concept, soil moisture characteristic curves - Water movement in soils - Infiltration, percolation, seepage, permeability and hydraulic conductivity - Saturated and unsaturated water flow.
5. Kinds of water in soil - Gravitational water, capillary water, hygroscopic water and their importance in crop production - Soil moisture constants - Saturation, Field capacity (FC) - Permanent Wilting Point (PWP) and hygroscopic coefficient - Available soil moisture (ASM)- Theories of soil water availability.
6. Plant- Water relationships - Rooting characteristics - Effective rooting depth and moisture extraction pattern - Moisture sensitive periods of crops - Soil Plant Atmospheric Continuum (SPAC).
7. Evaporation - Transpiration - Evapotranspiration - Factors influencing evapo transpiration - Reference evapotranspiration (ETo) - Crop evapotranspiration (ETc) - Crop coefficient (Kc) - Daily, seasonal and peak period consumptive use.
8. Crop water requirement - Irrigation requirement - Net and gross irrigation requirement - Irrigation interval - Irrigation period - Seasonal water requirement of important crops - Duty of water, delta and base period - Relation between duty, delta and base period - Conjunctive use of water - advantages.
9. Scheduling of irrigation - Soil moisture regime approach - Feel and appearance, soil moisture tension, ASMD method etc. - Climatological approach - Pan evaporation, IW/CPE ratio method etc. - Plant indices approach - Visual symptoms, growth rate, plant water potential, canopy temperature etc.
10. Methods of irrigation - Surface methods - Wild flooding, check basin, ring basin, border strip, furrow and corrugations - Advantages and disadvantages - Sub surface irrigation.
11. Micro irrigation systems - Sprinkler irrigation - Merits and demerits, system components and layout - Suitable crops - Rain guns.
12. Drip irrigation - Surface and sub surface drip - Merits and demerits - System components and layout - Suitable crops - Fertigation and maintenance of micro irrigation systems
13. Water Use Efficiency (WUE) - Crop and field water use efficiency - Factors influencing WUE - Climatic, genetic and agronomic factors - Irrigation efficiencies - Water conveyance efficiency, water application efficiency, water storage efficiency & water distribution efficiency - Project efficiency.
14. Quality of irrigation water - Salinity hazard, sodium hazard, residual sodium carbonate and boron toxicity - Criteria and threshold limits- Management practices for using poor quality water - Water logging - drainage, surface and sub - Surface drainage systems and relative merits
15. Water management in crops - Rice, wheat, maize, groundnut, sugarcane, mango, banana and tomato
16. Climate-based/smart irrigation practices - Artificial intelligence - Precision water management technologies - Automation in irrigation: moisture sensors, wireless

sensor networks, IoT application etc.

Practicals

1. Determination of bulk density of soil
2. Determination of soil moisture content by gravimetric and volumetric method
3. Installation and working with tensiometer and resistance blocks
4. Determination of infiltration rate
5. Determination of field capacity by field method
6. Measurement of soil moisture content by moisture probe
7. Measurement of irrigation water through flumes, weirs and V notches
8. Scheduling of irrigation by IW / CPE ratio method
9. Calculation of irrigation water requirements (problems)
10. Problems on duty of water and irrigation efficiencies
11. Lay out of surface irrigation methods, Furrow and check basin method of irrigation
12. Demonstration of drip irrigation system & Field cost estimation
13. Demonstration of operation of sprinkler irrigation system & field cost estimation
14. Demonstration of filter cleaning, flushing of laterals and fertigation practices
15. Design and laying out of underground pipeline system
16. Visit to micro irrigation systems in farmers' fields

Suggested Readings

1. Carr M. K. V. and Elias Fereres. 2014 Advances in Irrigation Agronomy. Cambridge University Press
2. Majumdar, D.K. 2014. Irrigation water management: Principles and practices. PHI learning Pvt Ltd, Delhi-92
3. Michael, A.M. 2009. Irrigation - Theory and Practice. Vikas Publ. House Pvt. Ltd., NewDelhi.
4. Reddy, S.R. 2016.Irrigation Agronomy 3rd Edition. Kalyani Publishers, Ludhiana.
5. Rao, Y.P. and Bhaskar, S.R. 2008 Irrigation technology. Theory and practice. Agro-tech publishing Academy, Udaipur
6. Sankara Reddy, G.H. and Yellamanda Reddy, T. 2006. Efficient Use of Irrigation Water. Kalyani Publishers, Ludhiana.

AGRO 301
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

Course Outlines

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, losses on growth and yield of crops; 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 on shift in weed flora in long term trials, Study of herbicide formulations and mixture of herbicide. Study methods of herbicide application, Herbicide spraying equipment, their parts, use and maintenance and colibration. 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.

Lecture Outlines

Theory

1. Weed -Definition- Characteristics of weeds - Harmful and beneficial effects of weeds
2. Classification of weeds based on morphology- Life cycle - Cotyledon number- Origin- Association- and special features with examples
3. Reproduction of weeds - Sexual Propagation - Vegetative propagation- Dissemination of weeds - agents of dispersal and mechanisms of weed seed dispersal
4. Crop weed competition- Critical period of crop weed competition-factors affecting crop weed competition, Allelopathy and weed seed bank
5. Weed management - Principles of weed management- Preventive, Physical / mechanical and cultural methods of weed management- Implements used in weed management and use of robots in weed management
6. Biological weed control- Types of bioagents-Selection criteria of a bioagent-Bioherbicides -Concept- Relative merits and limitations
7. Chemical weed control- Herbicide Definition- Advantages and limitations of herbicide usage
8. Classification of herbicides based on chemical nature/ selectivity/time of application/residues
9. Mode of action of herbicides- Important biochemical modes of action of herbicides interfering with photosynthesis- Respiration- Growth and development- Protein synthesis-Lipid synthesis
10. Adjuvant - Types of adjuvants and their advantages- Herbicide formulation - Definitions - Types-Relative merits- Precision weed management-Nano-herbicides
11. Herbicide selectivity-Fundamental principles of selectivity - Differential rate of absorption, translocation, metabolism and protoplasmic resistance.
12. Herbicide compatibility with fungicides, insecticides and fertilizers- Herbicide mixture-types- advantages and limitations of herbicide mixtures
13. Integrated weed management- Definition- Objectives- Advantages. Weed management in organic/ natural farming- Stale seed bed- Soil solarization- Mulches- Brown manuring - Bio-herbicides - Herbicide resistance - Reasons and its management
14. Weed management in different field crops - Yield loss- Weed flora and Management- Rice, Wheat, Maize, Jowar, Redgram, Greengram, Blackgram, Groundnut, Soybean, Sesame and Castor

15. Weed management in different filed crops- Yield Loss- Weed flora and Management in sugarcane, cotton- Horticultural crops - Onion, Chillies, Tomato, Turmeric
16. Aquatic weeds- types, problems caused by aquatic weeds and their control methods - Weed management in cropping systems

Practicals

1. Techniques of weed preservation
2. Weed identification
3. Survey of weeds in different ecosystems.
4. Study of biology of important weeds, water hyacinth, purplenut sedge, barnyard grass, Cuscuta
5. Estimation of yield losses due to weeds in ongoing field experiments
6. Study of herbicide formulations and herbicide label information for different herbicides
7. Study of Herbicide application equipment
8. Calibration of spraying equipment for herbicide application
9. Study of different methods of herbicide application
10. Study of weed control implements including robots
11. Calculation of herbicide dose
12. Calculation of Weed control efficiency, weed index, density, frequency and abundance
13. Study of phytotoxicity symptoms of herbicides in different crops
14. Weed management in fallow lands/non cropped areas
15. Management of problematic weeds
16. Management of parasitic weeds.

Suggested Readings

1. Gupta, O.P. 2015. Modern Weed Management (4th edition), Agrobios (India) Ltd, Jodhpur
2. Rao, V. S. 2017. Principles of Weed Science (3rd edition), CBS publishers and distributors Pvt. Ltd., New Delhi.
3. Naidu, V.S.G.R. Hand Book of Weed Identification, Directorate of Weed Research, Jabalpur
4. Ross, M.A and Lembi, C.A. 1999. Applied Weed Science. (2nd edition), Prentice Hall of India Pvt Ltd, New Delhi
5. Tadulingam and Venkatanarayana D . 1935. A Hand Book of Some South Indian Weeds
6. Rajagopal A, Aravindan R, and Shanmugavelu K G 2015. Weed management of Horticultural Crops, Agrobios (India), Jodhpur
7. Das, T.K. Weed science basics and applications published by Jain Brothers, New Delhi
8. Leela Rani P., Srinivas G. and Spandana Bhatt P. Basic concepts of weed management 2018, ICAR, New Delhi.

AGMT 301
INTRODUCTION TO AGRO-METEOROLOGY
2 (1+1)

Objectives

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

Course Outlines

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, netradiation, 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, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rain making. Monsoon- Mechanism and importance in Indian agriculture; Weather hazards - Drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold - wave; Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production. Weather forecasting - Types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording, Measurement of total, short wave 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 analysisof 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 metods, crop weather calender.

Lecture Outlines

Theory

1. Terminology and definitions: Meteorology, Climatology, Agro meteorology, Agro climatology- Scope and importance of Agro meteorology.
2. Earth atmosphere - Its composition- Atmospheric weather variables - Extent and structure of atmosphere.
3. Humidity- Concept of saturation- Vapour pressure - Types of humidity- Effect of humidity on crops - Atmospheric pressure. Definitions of pressure, standard atmospheric pressure, its variation with height.
4. Solar radiation- Nature and properties of solar radiation- Conduction, convection and radiation- Solar spectrum- Distribution of solar radiation within the crop canopies- Physiological response of different bands of incident radiation - Short wave, long wave and thermal radiation- Solar constant, net radiation, albedo – Energy balance of earth - Solstices and Equinoxes.
5. 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
6. Effect of temperature on crops - Low air temperature and plant injury and high air temperature and plant injury- Soil temperature - Factors effecting soil temperature.
7. Wind -Types of wind - Planetary winds (trade winds, westerlies, polar easterlies, Cyclones and anti cyclones) - Periodic winds and local winds (sea and land breezes, mountain and valley winds) Daily and seasonal variation of winds - Effect of wind on crops
8. Precipitation- Process of precipitation- Forms of precipitation (solid, liquid and mixed)- Types of rainfall (Orographic, convectional and cyclonic)
9. Condensation - Forms of condensation (dew, fog, mist, frost and cloud)
10. Definition of Cloud - WMO classification of clouds - Artificial rain making
11. Monsoons- Significant features of Indian monsoons - South west monsoons and North east monsoons- Importance of monsoons in Indian Agriculture - Date of onset, Length of crop growing season
12. Weather hazards: Drought, floods, tropical cyclones- heat and cold waves and their management.
13. Agriculture and weather relations- Modifications of Crop Micro Climate - Climatic normal for crop and livestock production.
14. Weather forecasting - Importance - Types of weather forecast and their uses - Synoptic charts.
15. Remote sensing - Applications of remote sensing in Agriculture - Agrometeo -rological Advisory services in India.
16. Climate change- Climatic variability - Global warming, Causes of climate change and its impact on regional and national Agriculture.

Practicals

1. Visit to Agrometeorological Observatory, site selection and layout plan for Observatory
2. Exposure to Agrometeorological instruments and weather data recording
3. Measurement of albedo and sunshine duration
4. Computation of radiation intensity using bright sunshine hours
5. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis.
6. Measurement of soil temperature and computation of soil heat flux

7. Determination of relative humidity, dew point temperature and vapour pressure.
8. Measurement of atmospheric pressure
9. Measurement of wind speed, and wind direction, preparation of windrose
10. Measurement of rainfall, tabulation and analysis of rainfall data
11. Measurement of open pan evaporation and evapotranspiration
12. Computation of PET and AET
13. Preparation of Synoptic charts and weather report
14. Weather forecasting- types, methods, Preparation of crop weather calender.
15. GDD, HTU and PTU calculations and their interpretations- Calculation of time
16. Crop planning for climate change

Suggested readings

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

AGRO 302
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

Course Outlines

Theory

Agro-Forestry: Definition and scope of Agroforestry system, Type of Agro forestry system, potential of Agroforestry in India, Prevailing agroforestry system in NE India, MPTS - Definition, role of MPTS in agroforestry system, its selection for different agroforestry system, MPTS of NE India, Ecological aspects of Agroforestry system, tree - Crop interaction - Competition, nutrient recycling, Traditional Agroforestry as aviable choice to conserve Agro biodiversity in North- East India. Management of Agro - Forestry system, Role of agroforestry in soil and water conservation, wind break, shelterbelt - Definition, objectives., Socio - Economic aspects of Agroforestry system, Design and Diagnostic study of agroforestry system, Silviculture: Definition and scope of silviculture system, Propagation of tree species, Regeneration by seed, coppice, root suckers, Transplanting, stamp, 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 measure-

ment, Study of environmental parameters affecting AF System, Plant propagation methods, Pre-sowing seed treatment, Preparation of nursery bed exercise, practicing propagation techniques for trees, Afforestation method, practical training, pruning, coppicing, pollarding etc. Planting pattern and designs for plantation, natural and artificial regeneration, Design and diagnostic survey of agroforestry system, Evaluation of agro-forestrysystem 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.

Lecture Outlines

Theory

1. Agroforestry - Definition - Concept and Scope History- Importance and Principles of Agroforestry.
2. Type of Agroforestry systems- Potential of Agroforestry systems in India, Classification of Agroforestry systems based on crop rotation, arrangement and component combinations.
3. Multipurpose tree species - Definition - Role of MPTS in Agroforestry - Tree crop interaction - competition, nutrient recycling.
4. Traditional Agroforestry - A viable choice to conserve Agro biodiversity of India – Management of trees in agroforestry systems.
5. Role of agroforestry in soil and water conservation-Windbreaks, Shelterbelts – Definition, design, characters of tree species suitable for windbreaks and shelterbelts, factors affecting the degree of protection offered by wind breaks.
6. Ecological aspects of Agroforestry system- Socio- Economic aspects of Agroforestry system - Diagnostic study and Design of agroforestry systems.
7. Forests - definitions of basic terms related to forestry - Branches of forestry - Role of Forests in influencing various aspects - Climate, Soil and Human health and recreation.
8. Silviculture - Definition - Concept - Objectives - Scope - Salient features of Indian forest policies
9. Forest regeneration–Natural and Artificial- Objectives-Choice between natural and artificial regeneration-Essential preliminary considerations for regeneration.
10. Propagation of tree species- Field planting techniques and planting methods (seed, coppice, root suckers, transplanting, stump, branch cutting, rhizomes)
11. Nursery - Nursery bed preparation and management-Types of nurseries- Cultural practices for bare root and seedling, field handling of nursery stock.
12. Tending- definition - different tending operations - Weeding, cleaning, thinning, fire tracing, Coppicing, Pollarding, Irrigation, Soil working, Brashing - Thinning - Types-Crown classification.
13. Cultivation practices of important tree species (Eucalyptus, Subabul and Bamboo) - Site factors, root, crown, bole characters, phenology, nutritional, water requirement, ground operation, tending, harvesting and utility.
14. Cultivation practices of important tree species (Teak, Casuarina and Neem) - Site factors, root, crown, bole characters, phenology, nutritional, water requirement, ground operation, tending, harvesting and utility.
15. Forest Utilization – Major (Paper & pulp, Plywood, Match wood, Pencils, Sports goods, Artificial limbs, and Packing cases) and minor forest products (Tendu leaves, Essential oils, Resins, Gum, Lac, Tans and dyes,Incense products)

16. Horticulture and forage crops based agroforestry models developed by ICAR-IGFRI: Agroforestry models developed by Indian council of Forestry Research and Education-successful Agroforestry models for different Agro ecological zones of India and Andhra Pradesh

Practicals

1. Identification of tree species suitable for timber, fuel wood, fodder, Bio aesthetic, MPTS
2. Identification of tree species suitable for Agro forestry
3. Diameter measurements of trees using callipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees.
4. Height measurement of standing trees by shadow method, single pole method hypsometer/ altimeter
5. Study of environmental parameters affecting Agroforestry System
6. Application of pre-sowing seed treatments to forest tree seeds.
7. Layout of the nursery, nursery bed preparation and sowing
8. Methods of afforestation - Planting pattern and designs for forest plantation
9. Natural and artificial regeneration - Practice of training, pruning, Coppicing and Pollarding
10. Practice of propagation techniques for forest trees
11. Methods of Plant Propagation- Field planting techniques for natural and artificial regeneration of forests
12. Design and diagnostic survey of agroforestry system
13. Evaluation of agro-forestry system in concerned agro climatic zones
14. Visit to prevailing agroforestry systems and related important institutions.
15. Visit to Forest nurseries and Research stations/forest based industries
16. 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.
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.

AGRO 303
DRYLAND 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

Course Outlines

Theory

Dryland/Rainfed agriculture: Introduction, types and characteristics; History of dry land/rainfed agriculturein India; Problems and prospects of dry land/rainfed agriculture in India; Soil and climatic conditions prevalent in dry land/rainfed areas; Soil and

water conservation techniques, Drought: types, effect of water deficit on physiomorphological 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 andcrop specific dryland principles and practices for profitable and sustainable dryland farming and allied enterprises.

Practicals

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 thecountry and demarcation of rainfed area on map of India. Interpretation of meteorological dataand 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 ofseed 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.

Lecture Outlines

Theory

1. Dryland Agriculture - Introduction, definition classification of drylands and characteristics of drylands - History of dry land agriculture in India.
2. Problems and prospects of Dry Land Agriculture in India- Soil and climatic conditions prevalent in dry land areas.
3. Soil erosion - Definition - Losses due to erosion - Types of water and wind erosion - Nature and extent of wind and water erosion - Factors affecting erosion - Universal soil loss equation.
4. Soil and water conservation techniques - Agronomic and engineering measures
5. Long term rainfall analysis in relation to simple mathematical models and Forecasting the weather abnormalities
6. Length of Growing Period (LGP) and Soil Moisture Availability (SMA) and its impact on crop and cropping systems.
7. Tillage for dryland crops - Sub soiling - Setline cultivation - Modern concepts of tillage.
8. Suitable Crops, varieties and cropping systems for dry land - Crop management in dryland areas.
9. Drought- Definition, types of drought, effect of water deficit on physio- Morphological characteristics of the plants - Crop adaptations and mitigation strategies for drought.
10. Evapotranspiration - Measures to reduce evapotranspiration - Weeding, use of

mulches, anti- transpirants, windbreaks and shelterbelts.
11. Water harvesting- importance, structures - Farm pond technology - Supplemental irrigation - Efficient utilization of water through soil and crop management practices.
12. Contingent crop planning for aberrant weather conditions (late onset, prolonged dry spells and early withdrawal of monsoons) in red and black soils.
13. Land capability classification - Alternate land use systems.
14. Watershed - Definition, Concept, history, objectives and Principles of Watershed management
15. Components of Watershed management and factors affecting watershed management
16. IFS models for Sustainable dryland Agriculture.

Practicals

1. Climate classification based on different criteria
2. Rainfall analysis - Mean, standard deviation, variance and CV.
3. Studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons
4. Calculation of Length of Growing Period (LGP) and Soil Moisture Availability (SMA).
5. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo- transpiration demand of crops.
6. Critical analysis of rainfall and possible drought period in the country (Dry spells and wet spells).
7. Estimation of effective rainfall.
8. Studies on cultural practices, agronomic and mechanical measure for mitigating moisture stress.
9. Determination of Soil moisture and Moisture availability index.
10. Seed priming- methods of seed priming.
11. Assessment of meteorological drought.
12. Visit to watershed, characterization and delineation of model watershed.
13. Major dryland areas in India and their mapping.
14. Field demonstration on soil and moisture conservation measures.
15. Field demonstration of water harvesting structures/ Study of farm ponds as a source of supplemental irrigation.
16. Visit to dryland research station and study of dryland crops.

Suggested readings

1. A.K.Srivastava and P.K.Tyagi, 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, NewDelhi.
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. AgrobiosIndia. Jodhpur.
7. S.R.Reddy, 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.

8. T.Yellamanda Reddy and G.H.Sankara Reddy, 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.

MDC 100
FARMING BASED LIVELIHOOD SYSTEMS
3 (2+1)

Objectives

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

Course Outlines

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 & 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 & 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 & success factors in farming based livelihood systems, Schemes & programmes by Central & State Government, Public & 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 & changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of componentsof 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 & their functional aspects for integration of production, processing & 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 & profit analysis, Case study of Start-Ups in agri-sectors.

Lecture Outlines

Theory

1. AGRO - Status of Agriculture in India and AP - History of Agriculture pre and post-Independence - Green revolution
2. AGRO - Crops and cropping systems with respect to climate, soil and irrigation factors

3. AGRO - Area under cultivation of different crops-Production, productivity at national and state level - Scope and prospects of foreign exchange from different crops
4. AECO - Income of farmers and rural people from Agriculture and allied enterprises in India and AP
5. AGRO - Livelihood- Definition, concept and livelihood pattern in urban and rural areas in AP
6. AGRO - Agricultural Livelihood Systems (ALS) - Meaning, Concept, Approaches and Framework
7. AGRO - Indicators to study livelihood systems and Agricultural Livelihood Systems (ALS)
8. AGRO - Farming systems - Farming based livelihood Systems- Definition, concept, objectives Scope and Importance of Farming based livelihood Systems
9. AGRO - Prevalent Farming Systems in India and AP- Contribution to Livelihood
10. AGRO - Types of Traditional and Modern farming systems- Merits and demerits
11. AGRO/LSPM - Components of Farming systems/ Farming - Based Livelihood Systems - Crops and cropping Systems, sericulture, apiary, mushroom, Livestock (Diary, Piggery and rabbit)
12. AGRO/LSPM - Components of Farming systems/ Farming - Based Livelihood Systems - Crops and cropping Systems, Livestock (Goatry, Poultry and Duckery etc)
13. AECO/LSPM - Small, medium and large enterprises - Value chains - secondary enterprises for Crops and cropping Systems and Livestock (Diary, Piggery, sericulture, apiary, mushroom and rabbit)
14. AECO/LSPM - Small, medium and large enterprises- Value chains - secondary enterprises for Crops and cropping Systems and Livestock (Goatry, Poultry and Duckery etc.)
15. AGRO - Production potential and interaction between the components of Horticultural Crops- Agro- Forestry systems, Aquaculture and Duck production
16. AGRO - Production potential and interaction between the components of Horticultural Crops- Agro - Forestry systems and Poultry cum Fish production, Dairy cum Fish and Piggery cum fish production
17. AECO - Small, medium and large enterprises - Value chains and secondary enterprises for Horticultural Crops
18. AGRO - Agro- Forestry systems, Aquaculture, Duck, Poultry cum Fish
19. AGRO - Factors affecting integration of various enterprises of farming for livelihood -climatic, Socio- economical, degree of commercialization and water availability
20. AGRO - Feasibility of different farming systems for different Agro- climatic zones of AP
21. AECO - Commercial Farm based livelihood models supported by NABARD, ICAR, ANGRAU and other Organisations
22. AECO - Case studies on different livelihood enterprises associated with the farming
23. AGRO - Farming - based livelihood systems-Risk and success factors
24. AECO - Schemes and Programmes by Central and State Government in promotion of farming-based livelihood opportunities
25. AECO - Schemes and Programmes by Public and Private Organisations in promotion of farming - based livelihood opportunities
26. AECO - Circular economy- green economy-concept, significance - Role of Farming based livelihood enterprises in 21st century- quantification and mitigation of GHG's

27. AGRO - Role of Farming based livelihood enterprises in 21st century in view of climate change, meaning and concept of climate change
28. AGRO - Mitigation and adaptation strategies of climate change with special emphasis to Farming systems and nexus with green economy and circular economy
29. AECO - Digitalisation- meaning, concept, Supply - demand-history, marketing of produce, Market fluctuations
30. AECO - Digitisation in Agriculture- different digital /online platforms, successful apps in Agriculture with changing life style
31. AECO - Agri-Tourism - Introduction and importance -Scope in India - Advantages for Agritourism - constraints - Management of Resourses.
32. AECO - Forms of Agritourism - Requirements for Agritourism - Govt. policies & Legislations in respects to Agritourism - Marketing Strageis for Agritourism products & Sevices.

Practicals

1. AGRO - Survey of farming Systems and Agricultural based Livelihood enterprises
2. AGRO - Study of components of important Rainfed Farming based livelihood models/ Systems in different Agro- climatic Zones (Wetland)
3. AGRO - Study of components of important Rainfed Farming based livelihood models/ Systems in different Agro- climatic Zones (Lowland)
4. AGRO - Study of components of important Rainfed Farming based livelihood models/ Systems in different Agro- climatic Zones (Gardenland)
5. AGRO - Study of production and profitability of crop based, livestock-based livelihood models (poultry/ goatry/ sheep)
6. AGRO - Study of production and profitability of crop based, livestock-based livelihood models (Duckery/ Aquaculture)
7. AGRO - Study of production and profitability of crop based, livestock-based livelihood models (Diary)
8. AGRO - Study of production and profitability of processing based livelihood models
9. AGRO - Study of production and profitability of integrated farming-based livelihood models
10. AGRO - Field visit to innovative Farming system models in farmers' fields
11. AGRO - Field visit to innovative Farming system models in Agricultural Research station
12. AECO - Visit to Agribased enterprises and their functional aspects for integration of production, processing and distribution sectors
13. AECO - Study of Value chain models - Agri enterprises involved in Industry
14. AECO - Study of Value chain models - Agri enterprises involved in service sectors
15. AECO - Concept of project formulation on farming based livelihood systems - cost and profit analysis
16. AECO - Case study of startups in agri - sectors/ Agritourism centres.

Suggested Readings

1. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience;
2. Department for International Development: London, UK; Volume 7. [Google Scholar]
3. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Envi-

ronment, New Delhi, India.
4. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.
5. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving
6. Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington,DC, USA
7. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
8. Livelihood Improvement of Under privileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar.
9. Baishya, A., Borah, M.., Das, A.K., Hazarika, J., Gogoi, B and Borah, A.S, 2017. Waste Recycling through Integrated Farming Systems. An Assam Agriculture Experience. Omni Scriptum Gmbh & Co. KG, Germany.
10. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification,
11. Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
12. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
13. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
14. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.
15. Nanwal, R.K. 2019. Farming system and sustainable agriculture. New India publishing agency - Nipa, India.
16. Ravisankar, D and Jayanthi, C. 2015. Farming systems: concepts and approaches. Agrobios,
17. Recent Advances in Integrated Farming Systems.Rana SS 2015.Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur,
18. Integrated Farming System: A Strategy for Sustainable Farm Production & Livelihood Security. 2016. Ravikiran Vasant Mane. Scitus Academics. ISBN:1681170728, 9781681170725
19. Systems Research for Agriculture: Innovative Solutions to Complex Challenges. Laurie E. Drinkwater. Sustainable Agriculture Research and Education (SARE) Program, with funding from the National Institute of Food and Agriculture, U.S. Department of Agriculture.ISBN:9781888626162, 188862616X.
20. Farming system and Sustainable Agriculture. SS. Walia. US Walia, Scientific Publishers (India). eISBN:978- 93-88812-92-4.
21. Gangwar, B. and Singh, Anil Kumar (2011). Efficient Alternative Cropping Systems. Project Directorate for Farming Systems Research, Modipuram, Meerut, India.pp. 339.

22. Singh S. P. 2012. System based estimation of cost of production and profit maximization with special reference to nutrients In System based integrated nutrient management 2012 by B.Gangwar& V. K. Singh (eds), New India Publishing Agency, New Delhi (India) PP 138-148.
23. Singh, K. K. 2012. Resource Conservation Technologies for Improving Nutrient Use Efficiency. In: "System Based Integrated Nutrient Management for Sustainable Crop Production and Soil Health", B. Gangwar&V. K. Singh (eds.), pp. 261-276. (in press).
24. Singh V. K. 2011. Strategies and Approaches for Inclusion of Legume in Cropping Systems for Sustainable Productivity and Crop Health. IPNI-ISSS collaborative publication on nutrient efficient technologies.

Websites

1. https://iifsr.icar.gov.in/icar-iifsr/publications/books-chapters/
2. https://agritech.tnau.ac.in/agriculture/agri_majorareas_ifs.html
3. https://www.coabnau.in/uploads/1609844393_Agron.5.6.pdf
4. https://www.fao.org/sustainability/en/
5. https://www.fao.org/organicag/oa-faq/oa-faq1/en/

SEC XIV
AGRICULTURAL WASTE MANAGEMENT
2 (0+2)

Practicals

1. AGRO - Agricultural Waste- Generation of waste - Sources of wastes - Classification - Waste categorization
2. AGRO - Waste management- Functions- production, collection, storage, treatment, transfer, utilization- Nature and characteristics of agricultural waste - Kinds of waste - Problems of waste - Hazardous and nonhazardous waste
3. AGRO - Sources of waste - Crop residues - Process residues- status of production - Challenges- Management options for sustainability
4. AGRO - Technologies for waste management- Smart waste bins- Waste level sensors- AI recycling robots- Garbage truck weighing mechanisms- Pneumatic waste pipes-Solar-powered trash compactors-E-waste kiosks- Recycling apps
5. AGRO - Plastic waste -E waste - Collection- Sorting- Disassembly- Repurposing- Recycling 3 R's Concept- Challenges- Implications - Opportunities- Extended producers' responsibility - Environmental impact.
6. AGRO - Waste Management - Waste-to-energy conversion- Bio methanation - Bio char - Gasification- Incineration- Pyrolysis- Anerobic digestion- Land fill recovery-Bio fuel (Bio CNG)- Bio oil- Benefits - Challenges and Considerations
7. SSAC - Composting- Methods of composting- Types of composting- (ADCO, Activated, Bangalore, Coimbatore, NADEP, Rainwater, Mechanical, sugarcane trash compost)- Advantages.
8. SSAC - Vermicomposting - Vermitechnology-Types - Raw materials- Starters - Methods of preparation - Advantages
9. SSAC - Bio gas production technology - Janata, Deena bandhu, Pragathi - Components- Benefits - Applications- Challenges and Future prospects.
10. AGRO - Management of bedding and litter - Types of bedding and litter material- Litter amendments and litter utilization
11. SSAC - Waste decomposer - Role of decomposers-Types- (Ghaziabad & Amaravathi)

Procedure for preparation- Usage- Environmental impact- Management of residues through waste decomposer.

12. AGRO - Waste recycling - Farming systems approach- Rice- Live stock, Rice - Fish- Rice- Fish and Poultry.
13. AGRO - Creating wealth from waste- Materials needed (paddy straw- Maize Cobs-Coconut fronds- Cotton stalks-Banana stem). Idea generation- Design and planning and creation.
14. AGRO - Occupational hazards - associated with waste handling - Infections - Chronic Diseases - Effect of heavy metals on human health.
15. AGRO - Waste Management equipment - Operation procedure of Waste management machineries - Criteria for selection of waste handling equipment- (Hand scrapers, shovels, brooms, washers) - Waste transfer - (Augers and conveyors)- Waste storage equipment - Waste treatment equipment (Agitators, stirrers,mixers)
16. AGRO-Visit to Agro based industries-Sugar/ Dairy/ Paper/ food processing/Bio fuel/ Agro processing industries Cereal/ fruit and vegetable/Dairy
17. AGRO-Visit to Wealth from waste centers /Solid waste management yards/ Recycling centers/ Solid waste collection centres /Recycling plants/ Composting units/ Waste to energy plants and Landfills
18. SSAC-Determination of moisture through gravimetric method
19. SSAC-Preparation waste sample and analysis of waste sample and Determination of pH, EC, CEC
20. SSAC-Determination of heavy metals- Lead- Nickel- Cromium
21. SSAC-Determination of BOD, COD
22. SSAC-Determination of TDS, NH4
23. SSAC-Determination of total P
24. SSAC-Determination of N in agricultural waste
25. SSAC-Determination of K in agricultural waste
26. SSAC-Determination of Calcium Megnesium and Sulphur in agricultural waste
27. SSAC-Determination of micronutrients in agricultural waste
28. SSAC-Determination organic carbon and C: N ratio
29. AGRO-Survey of different agri-wastes from livestock, dairy and poultry
30. AGRO-Survey of different agri-wastes from food processing, fruit and vegetable and agrichemicals
31. AGRO-Waste water treatment for re use in Agriculture
32. AGRO-Visit to sewage treatment plant /bio gas plant

SEC XV

ORGANIC PRODUCTION TECHNOLOGY

2 (0+2)

Practicals

1. AGRO-Organic farming - Types - Scope - Prospects of organic farming
2. AGRO-Organic manures - Classification - Identification
3. AGRO-Farmyard manure - Methods of preparation - Enriched FYM
4. AGRO-Compost- Types - Aerobic and anaerobic methods of composting- NADEP compost
5. AGRO-Vermi compost - Methods and processes of production

6. AGRO-Preparation of liquid organic manures - Panchagavya, Jeevamrutha, Beejamrutha
7. AGRO-Preparation of special liquid organic manures - Amritpani, Vermiwash, Compost tea
8. AGRO-Green manure crops - Identification - Incorporation of green manure crops.
9. AGRO-Concentrated organic manures - Production and application of oil cakes-Matkha Khaad
10. AGRO-Crop residue management in organic production
11. AGRO-Bio fertilizers - Types - Methods of Bio-fertilizers application in various crops
12. AGRO-Mass production and field application of Azolla
13. AGRO-Seed treatment with Bio-fertilizers - Seedling treatment with liquid Bio-fertilizers
14. AGRO-Organic nutrient management in crops and cropping systems
15. AGRO-Organic weed management in crops and cropping systems
16. ENTO -Study of Indigenous technical Knowledge for Insect pest management in organic farming - Application of panchagavya, sour butter milk, beejamrutham and jeevaamrutam to combat insect pests in organic farming.
17. ENTO -Study and preparation of NSKE, PSKE, Custard leaf extract, tobacco decoction - Bioefficacy studies, Field application.
18. ENTO -Study, preparation and bio-assay of cow based plant extracts and their effect against insect pests in organic farming - Neemastra, Agniastra, Brahmastra , vavilaku, Ipomia kashayam and Dasapatra kashayam.
19. ENTO -Study and mass production of microbial insecticides viz., Entomopathogenic fungi /NPV/ Entomopathogenic nematodes.
20. PATH-Seed treatment and seed pelleting with fungal and bacterial biocontrol agents
21. PATH-Mass multiplication of Trichoderma on farm yard manure (FYM)
22. PATH-Mass multiplication of Pseudomonas fluorescens and Bacillus subtilis on FYM
23. PATH-Seedling dip, foliar spray and soil application of biocontrol agents
24. AGRO-Organic production technology package in important crops
25. AGRO-Organic certification procedures
26. AGRO-Post harvest management in organic production and marketing
27. AGRO-Study of quality aspects of organic products: Grading, Packing and Handling
28. AGRO-Case studies of ITK's for organic nutrient & weed management
29. AGRO-Visit to organic fields/farms/cluster
30. AGRO-Visit of organic experiments (Onfarm / Off farm)
31. AGRO-Visit to Organic FPO/ organic stores
32. AGRO-Economic analysis of organic production

Suggested readings

1. A.C.Gaur. Hand book of Organic farming and biofertilizers.
2. A.K.Dahama. Organic farming for sustainable agriculture. Agrobios(India), Jodhpur.
3. Arun. K. Sharma. Hand book 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, Udaipur.
6. G.K.Veeresh. Organic farming. Foundation Books. New Delhi.

7. Purshit,S. S. Trends in Organic Farming in India. Agrobios (INDIA), Jodhpur.
8. Thampan, P.K. Organic Agriculture. Peckaytree Crops Development Foundation, Cochin, Kerala.
9. Sathe,T.V. Vermiculture and Organic Farming. Days Publishing House, New Delhi.

ELCT 401
SYSTEM SIMULATION AND AGRO ADVISORY
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

Course Outlines

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

Lecture Outlines

Theory

1. Crop simulation modelling-Types of crop models- Empirical Models-Mechanistic models- Introduction to Systems and Modeling
2. Computer Simulation of Dynamic Models- Introduction to Different crop models-DSSAT-APSIM & INFOCROP
3. Crop Modeling- history of agricultural system modelling- Spatial and temporal scales of agricultural system models - State variables and model Development
4. Modelling plant growth and development and yield
5. Modelling Dry matter growth - Photosynthesis, respiration - Light Use Efficiency (LUE) - Partitioning of dry matter

6. Crop growth models parameterization
7. Modelling soil nitrogen - Mineralization - Immobilization - Leaching - Plant uptake
8. Modelling carbon balance and C sequestration
9. Modelling Methane, Carbon-di-oxide & Nitrous oxide emission
10. Modelling crop-environment (soil, weather) interactions
11. Modelling soil-water balance
12. Model initialization-data standards-concept of potential yield- Attainable Yield - Actual yield
13. Data requirement for running a simulation model, data collection and minimum datasets
14. Crop model application steps– Model calibration
15. Crop model application - Model evaluation & sensitivity analysis
16. Cropping rotations- Simulations of crop rotations- Using computer simulation models- Soil organic carbon dynamics in crop rotation simulations
17. Artificial intelligence- Machine learning -Hybrid modelling - Recent developments in simulation modelling-Use of AI & ML in crop models
18. Elementary crop growth models - Verification and sensitivity analysis
19. Climate change - Climate variability - Use of simulation models - To address the climate change and variability
20. GIS-Remote sensing- GPS - Use of spatial tools in agriculture- Spatial modelling.
21. Climate change scenarios- Introduction IPCC scenarios, concepts - Climate change studies using simulation models - Data utilization methods
22. Adaptation- Mitigation - Simulating climate change impacts - Adaptation strategies - Gains and vulnerability
23. GHG emissions- Indian scenarios - Emissions from Agricultural sector - Modelling GHG emissions from agriculture and mitigation strategies for climate change
24. Ecological Niche modelling- Concepts and uses
25. Application of simulation models for crop choice and agricultural management (Fertilizer -water management)
26. Yield forecasting- Yield forecast techniques using simulation models and linking remote sensing technology
27. Application of crop models for environmental risk analysis
28. Cropping system models and their use in Agriculture
29. Pest and disease modelling and their application in early forewarning
30. Crop production in moisture and nutrients limited conditions by using simulation models
31. Using the model in an optimization mode to solve for crop or genetic traits
32. Evaluate weather risks to production (yield and net profit) using simulation models
33. Development and evaluation of best management practices (BMPs) to minimize nitrate leaching or irrigation water use.
34. Use of models for foresight analysis
35. Define STCR (Soil Test Crop Response) - STCR for precision agriculture technique
36. Crop insurance- weather index based crop insurance - Cropping system models for decision-making for crop insurance
37. History and development of weather forecasting in India
38. Crop-Weather Calendar, Crop-Weather-Pest-Disease Calendar and forewarning model, Crop weather diagram

39. Value added weather forecast, ITK for weather forecast and its validity. Aerospace science and weather forecast
40. Weather forecasting types and their uses
41. Role of medium range weather forecasting with special emphasis to agriculture
42. Concept and development of weather based agro advisory services
43. Steps in preparation of weather based agro advisories
44. Dissemination of Agro advisories to farming communities
45. Role of ICTs in dissemination of Agro advisories
46. Economic impact of agro advisories
47. Role of AFMU in preparation and communication of agro advisories
48. Use of AI & ML tools for seamless delivery of agro advisories

Practicals

1. Working with weather data and preparation of climate analytics using R/Python
2. Data and input file preparation for crop models
3. Working with Statistics in Simulation modelling (Random Sampling, Monte Carlo Methods, Bayesian Statistics etc)
4. Climate scenario data generation methods/ steps
5. Simulating Nitrogen balance using models
6. Simulating water balance using models
7. Simulating crop growth using models
8. Hands on exercise of model calibration
9. Hands on exercise of model calibration
10. Simulating environmental modification using simulation models
11. Uncertainty and Sensitivity Analysis
12. Yield forecast using simulation models
13. Understanding forecast data and interpretation
14. Preparation of weather based agro advisories using medium range weather forecasting data
15. Use of ICTs for better dissemination of Agro advisories
16. Economic impact of the agro meteorological advisory services-Case study

Suggested readings

1. H. S. Mavi. Introduction to Agrometeorology
2. G.S.L.H.V. Prasado Rao Agricultural Meteorology by
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. M.C. Varshneya and P.B. Pillai. ICAR. Text Book of Agricultural Meteorology
5. OP Bishnoi Principles of Agricultural Meteorology

ELCT 402
CLIMATE RESILIENT AGRICULTURE
4 (3+1)

Objectives

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

Course Outlines

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, agroadvisories, 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.

Lecture Outlines

Theory

1. Basic concept of weather, climate, climate variability and climate change - Introduction to greenhouse effect (GHE), greenhouse gases (GHGs), global warming and global warming potential (GWP)

2. Trends and fluctuations of major climatic parameters and associated climate changes; Impact of climate change in agriculture sector-Global- Country- state and regional level
3. Crop productivity under different climate change scenarios
4. What are extreme events- Drought, flood, pest and disease outbreaks- Crop production under these extreme events.
5. Concept of climate change adaptation and mitigation in agriculture- Analysing and assessing climate vulnerability to identify vulnerable sectors and possible adaptation options on agriculture and allied sectors
6. Assessing biophysical and socio-economic impacts of climate change across - Agriculture, Agro industry, Forestry
7. Risk assessment strategies - Preparedness for weather and climate risks
8. Define Adaptation and Mitigation- Explain basics of adaption and mitigation in the agricultural sectors
9. Define Climate Resilient Agriculture (CRA) & Greenhouse gasses (GHG) - Need to adopt Climate Resilient Agricultural (CRA) practices- Ways to reduce GHG emissions from agriculture
10. Assessing biophysical and socio-economic impacts on agricultural sector.
11. What are Weather and climate risks -Risk assessment strategies- preparedness for weather and climate risks in agriculture
12. Climate Resilient Agriculture (CRA)- Concept- Scope and importance- History of CRA with special reference to India & AP
13. What are climate resilient technologies - Role of climate resilient technologies for enhancing crop productivity and sustainability
14. Contingency planning- How to develop Crop contingency planning based on agro-climatic conditions
15. Contingency planning based on rainfall patterns, dry spells, soil types, and real-time weather conditions
16. Agrometeorology-Weather forecasting -Role of weather forecasting in intelligent farming - weather forecast in assisting farmers in anticipating and coping with changes in climate.
17. Role of agroadvisories and ICTs to promote climate resilient technologies
18. Define Crop modelling- Types of crop models-Empirical Models-Mechanistic models
19. Role of simulation models for developing climate resilient technologies
20. Different climate resilient agronomic practices - Crop/cultivar selection, crop diversification/ crop mixtures
21. Water management practices - Rain water harvesting
22. Micro-irrigation, deficit irrigation and drainage management
23. Organic/natural farming, Integrated Farming Systems (IFS); site specific nutrient management (SSNM)
24. Conservation agriculture technologies to build soil organic carbon
25. Harnessing microbial biodiversity, biomass recycling
26. Use of renewable sources of energy
27. Climate resilient pest management strategies
28. Climate resilient disease management strategies
29. Strategies for development of climate change resilient crops and varieties- Physio-

logical -Morphological
30. Development of biotic and abiotic stress tolerant/resistant cultivars under changed climatic scenarios
31. Development of biotic and abiotic stress tolerant/resistant cultivars for extreme weather events.
32. Geospatial tools -GIS-GPS- & RS-Role of geospatial tools and techniques for sustainable agriculture
33. Climate adaptation and mitigation -Strategies and technologies for climate change adaptation
34. Climate Smart Crop Development: Introduction-climate smart crops and their development- Strategies being adopted to develop climate smart crops
35. Climate resilient management strategies - Rice
36. Climate resilient management strategies - Wheat
37. Climate resilient management strategies - Maize
38. Climate resilient management strategies - Sorghum
39. Climate resilient management strategies - Major and minor millets
40. Climate resilient management strategies - Sugarcane
41. Climate resilient management strategies - Cotton
42. Climate resilient management strategies - Pigeon pea- Chickpea
43. Climate resilient management strategies - Blackgram, Greengram
44. Climate resilient management strategies - Oil seed crops
45. Climate resilient management strategies - Fisheries
46. Climate resilient management strategies - Livestock
47. Climate resilient management strategies - Major horticulture orchard crops
48. Climate resilient management strategies - Major horticulture vegetable crops

Practicals

1. Acquaintance with meteorological instruments including AWS
2. Statistical techniques to study trends and fluctuations of climatic parameters
3. Analysis of extreme weather events using non-parametrictests
4. Building climate change scenarios under different futuristic emission of GHGs
5. Climate change laboratory and simulation experiments using crop simulation models
6. Designing strategies to mitigate the effect of climate change using climate resilient crops/cultivars
7. Climate resilient technologies and manipulation of cropping patterns
8. Acquaintance with ICTs for effective dissemination of local weather information and agro-advisories
9. Analysing carbon sequestration potential of different agro-ecosystems;
10. Designing of a 'climate smart village' model considering the availability of resources.
11. Awareness programme on climate change and climate resilient agriculture among farming community.
12. Economic analysis of climate smart interventions-a cost benefit analysis
13. Field visit - Research station/Cyclone warning station
14. Field visit - Research station- Climate smart trials
15. Field visit - Farmers field- Climate smart villages
16. Field visit - Farmers field- Climate smart villages

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.

ELCT 403
PRINCIPLES AND PRACTICES OF ORGANIC FARMING AND CONSERVATION AGRICULTURE
4 (3+1)

Objectives

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

Theory

Concept of organic farming, principles and its scope in India; Choice of crops and varieties in organic farming; Nutrient management in organic farming and their sources; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and crop standards of organic farming; Processing, labelling, economic considerations and viability, marketing and export potential of organic products. Initiatives taken by Government (central/ state), NGOs and other organizations for promotion of organic agriculture. Conservation agriculture: definition, origin, principles, advantages, challenges; Primary practices in conservation agriculture: minimum soil disturbance, crop residue retention, and crop diversification, complementary practices, conservation agriculture vis a vis Climate Smart Agriculture; Organic manures- Recommended doses and application in comparison to inorganic fertilizers for major crops

Practical

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost and their quality analysis; Method of application of bio-fertilizers; Indigenous technology knowledge (ITK) for nutrient, insect-pest and disease management; Studies 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.

Lecture Outlines

Theory

1. Organic farming - Definition - Need - Concept - Scope - Characteristics - Relevance to modern agriculture.
2. History - Evolution of organic farming - Milestone in early ages

3. Organic farming- principles - Choice of crops and varieties in organic farming Crop rotations - need and benefits - Multiple cropping.
4. Different ecofriendly farming systems- Biological farming, natural farming, Re generative agriculture - Permaculture - Biodynamic farming with advantages and disadvantages
5. Relevance of organic farming to India, A.P and global agriculture and future prospects- Advantages - Barriers to organic farming
6. Initiatives taken by the central and state governments, NGO's and other organizations for promotion of organic agriculture
7. Organic nutrient sources and its fortification - Organic manures- Methods of composting
8. Green manures- bio fertilisers - Types, methods of application - Benefits and limitation.

9,10&11. Nutrient use in organic farming- Scope and Limitations- Nutrient manage ment in organic farming- Preparation and use of liquidorganic manures
12. Recommended package of practices in organic farming for major crops- Rice / Maize/Pulses/Millets/ Cotton/Sugarcane
13. Concepts of organic farming ecosystem
14&15 Fundamentals of insect and disease under organic production- Cultural Biological methods- Non chemical pest and disease management
16. Weed management under organic production
17. Use of botanicals- Pyrethrum, neem seed kernel extract, neem seed powder, neem oil and other neem formulations
18. Operational structure of NPOP- Other agenices for organic production
19&20. Certification process- Inspection- Certification- Labelling and Accreditation procedures for organic products- Processing- Economic consideration and viability
21. Marketing and export potential of organic products- National economy
22. Significance of organic farming in maintaining soil health and it's quality
23. Role of organic farming in maintaining crop yield and it's quality
24. Impact of organic farming on climate change
25. Organic crops & foods and their impact on human health
26. Organic seed production- Success stories- Case studies - ITK'S in organic farming
27. Conservation Agriculture - Definition, Concept, Objectives - Conventional Agri culture vs Conservation Agriculture
28. Conservation Agriculture- History , global options and opportunities - Current scenario
29. Conservation Agriculture- Principles- Minimum soil disturbance - Permanent soil organic cover-crop diversification
30. Conservation Agriculture-benefits and constraints-Operational, Technical and Socio- Economic issues
31&32. Types of Conservation Agriculture- No till farming- Crop rotation- Conserva tion tillage- Cover crops- Stubble mulch farming- Crop residue management- Legume farming- Organic farming-Agroforestry - Precision farming- Carbon farming

33. Conservation Agriculture - Modern concepts of tillage- Zero, minimum and conservation tillage- conventional tillage vs conservation tillage and impact on soil properties
34. Crop residue management- Generation of crop residues in India - Utilization and on farm burning- Reasons behind on farm burning of crop residues
35. Competing uses of crop residues-Energy source, Livestock feed, Compost making, Bio fuel and bio-oil production, biochar production, Gasification - Biomethanation
36. Management strategies for crop residues in different countries - Managing crop residues with Conservation Agriculture
37. Crop diversification - Definition-Concept - Types: Horizontal - Vertical diversification - Advantages- Challenges- Issues
38. Cover crop characteristics/functions and management in Consertion Agriculture
39&40. Crop establishment under conservation Agriculture- Machinery, tools and implements required for Conservation Agriculture
41. Conservation Agriculture vis a vis Climate Smart Agriculture
42. Green house gas emissions in Conventional Agriculture - Conservation agriculture - Carbon sequestration
43. Diversifying crop rotations with nitrogen fixing legumes
44. Strategies for improving C/N dynamics for climate resilient farming in Conservation Agriculture
45. Conservation Agriculture - Agroforestry systems - Complementary benefits- Sustainable development principles
46. Conservation Agriculture - Major cropping systems in India- Rainfed and irrigated conditions
47. Conservation Agriculture - Mulches – Advantages - Disadvantages - Management
48. Conservation Agriculture - Challenges - Policies - Adoption of CA - Research strategies in India

Practicals

1. Visit to organic farm to study the various components, identification and utilisation of organic products
2. Vermicompost preparation
3. Compost making- aerobic and anaerobic methods
4. Preparation of enriched farm yard manure
5. Preparation and application of panchagavya, beejamrutam, jeevamrutam, ghana jeevamrutam, dravajeevamrutam
6. Methods of application of Bio-pesticides (Tricho cards, BT, NPV)/Biofertilizers
7. Different weed management practices- Mulches- Stale seed bed etc.,
8. Quality standards of biofertilisers/bioinoculants and compost
9. Study of post-harvest management in organic farming
10. Preparation and application of Neemastra etc.,
11. Visit to organic farms to study the various components and their utilization
12. Economic- Organic production system
13. Estimation of weed seed bank in Conservation Agriculture
14. Direct seeding equipment methods under conservation agriculture - Broadcasting,

Planting stick, Hand jab planter, Motorized or tractor drawn seed drill, Happy seeder, Roto till drill, multi crop raised bed planter, slit till drill, Animal drawn planter

15. Study of cover crop in conservation Agriculture
16. Case studies of Conservation agriculture in Rainfed Areas

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.

GENETICS AND PLANT BREEDING

GPBR 211
PRINCIPLES OF GENETICS
3 (2+1)

Objective

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

Course Outlines

Theory

Pre and post Mendelian concepts of heredity, Mendelian principles of heredity, Study of model organisms (Drosophila, Arabidopsis, Gardenpea, 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 celldivision-mitosis and meiosis. Probability and Chi-square. Types of DNA and RNA, Dominance relationships, Epistatic interactions with example, Introduction and definition of cytology, genetics and cytogenetics and their inter relation.

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 backcross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and chi-square test, Determination of linkage and cross-over analysis (through two point test cross data), Study on sex linkedin heritance in Drosophila. Study on models on DNA and RNA structures.

Lecture Outlines

Theory

1. Introduction and definition of cytology, genetics and cytogenetics and their interrelation. Pre and post Mendelian concepts of heredity - Early history of heredity, inheritance of acquired traits, preformation theory, pangenesis and germplasm theory.
2. Study of model organisms (Drosophila, Arabidopsis, Garden pea, E.coli, and mice).
3. Chromosome - Architecture of chromosomes, chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere, types of chromosomes based on position of centromere.
4. Special types of chromosomes - Polytene chromosomes, Lampbrush chromosomes, B or Accessory chromosomes and Isochromosomes.
5. Cell division - Cell cycle - Mitosis - Process of mitosis - Significance.

6. Meiosis - Process - Differences between mitosis and meiosis - Significance.
7. Mendelian principles of heredity - Terminology, Mendel's experiments - Reasons for selection of pea as experimental material- characters studied - Reasons for Mendel's success.
8. Mendel's laws - Law of segregation - Law of independent assortment - Principle of dominance - Principle of unit characters - Exceptions to mendel's laws - Rediscovery of mendelian principles.
9. Chromosomal theory of inheritance- Chromosomal basis for Law of segregation and Law of independent assortment.
10. Probability (Addition and Multiplication rule) and Chi-square test.
11. Dominance relationships - Complete dominance, incomplete dominance, codominance, over dominance, pseudo domiance, lethal factors.
12. Gene interaction - Nonepistatic interaction - Interaction of factors; epistatic interactions - Complementary epistasis, dominant epistasis.
13. Recessive epistasis, duplicate dominant gene action, dominant suppression or inhibitory gene action, duplicate genes with cumulative effect.
14. Multiple alleles - Characteristics of multiple alleles - Blood groups in humans, coat colour in rabbits, self incompatibility alleles in plants - Test of allelism - pseudoalleles - pleiotropism, penetrance and expressivity.
15. Qualitative and Quantitative traits, Polygenes and continuous variations - Definition - Inheritance and their differences, multiple factor hypothesis.
16. Linkage - Types of linkage - Characteristic features of linkage - Detection of linkage -Linkage groups.
17. Crossing over - Mechanism of crossing over - Types of crossing over - Cytological proof of crossing over in Drosophila - Chromosome mapping- two point test cross.
18. Sex determination - Mechanisms of sex determination - Chromosomal sex determination, genic balance theory in Drosophila melanogaster, male haploidy, single gene effects.
19. Sex linkage - White eye colour in Drosophila, colour blindness and haemophilia in humans - sex influenced traits - Horns in sheep, baldness in humans, sex limited traits - Milk production in cattle, beard in man - Pseudo hermaphrodites - Gynandromorphs.
20. Nature and structure of genetic material - DNA and its structure -Watson and Crick's model - Function - Types of DNA- Experiments to prove DNA as genetic material.
21. Replication of DNA - Modes of DNA replication - Semi-conservative DNA replication - Experimental proof.
22. Types of RNA - Messenger RNA, ribosomal RNA and transfer RNA - structure of tRNA, differences between DNA and RNA.
23. Protein synthesis - Central dogma - Genetic code - Properties of genetic code - Wobble hypothesis.
24. Steps in protein synthesis - Transcription, Post transcriptional modifications and translation.
25. Gene regulation - Lac operon concept - Gene concept - Cistron - Recon - Muton.
26. Mutation - Definition - Classification of mutations - Characteristics of mutations - Xenia and metaxenia - Chimeras Types and their significance.
27. Molecular Basis of Mutations - Methods of inducing mutations - Physical and chemical mutagens.

28. Structural changes in chromosome - Classification - Deletions (deficiency) - Duplications and their significance.
29. Inversions - pericentric inversions and paracentric inversions - inversions as cross over suppressors. Translocations - simple and reciprocal - their significance.
30. Numerical variations in chromosomes and their implications - Euploids (Haploids, diploids, dihaploids, doubled haploids, Autopolyploids and Allopolyploids).
31. Numerical variations in chromosomes and their implications - Anueploids-Hypoploids and Hyperploids (Nullisomics, Monosomics, Trisomics and Tetrasomics).
32. Cytoplasmic inheritance - Definition - Chloroplast inheritance (leaf variegation in Mirabilis jalapa) -mitochondrial inheritance (cytoplasmic male sterility in maize) - Characteristic features of cytoplasmic inheritance - Differences between chromosomal and extra chromosomal inheritance.

Practicals

1. Study of microscope.
2. Study of cell structure.
3. Mitosis cell division.
4. Meiosis cell division.
5. Practice on mitotic and meiotic cell division.
6. Problems on monohybrid, test cross and back cross.
7. Problems on dihybrid, test cross and back cross.
8. Problems on trihybrid, test cross and back cross.
9. Problems on probability.
10. Problems on chi-square test.
11. Problems on epistatic interactions including test cross and back cross.
12. Problems on epistatic interactions including test cross and back cross.
13. Problems on epistatic interactions including test cross and back cross.
14. Determination of linkage and cross over analysis (through two point testcross data).
15. Study on sex linked inheritance in Drosophila.
16. 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.

GPBR 212
BASICS OF PLANT BREEDING
3 (2+1)

Objectives

1. 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.

Course Outlines

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 a sexually 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, Design sused 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.

Lecture Outlines

Theory

1. Plant Breeding - Definition, aim, objectives, history and developments of plant breeding, scientific contributions of eminent scientists - Landmarks in plant breeding - Scope of plant breeding.
2. Modes of reproduction - Asexual reproduction (vegetative reproduction and apomixis) and sexual reproduction - Their classification and significance in plant breeding.
3. Modes of pollination - Classification of crop species based on mode of pollination - Mechanisms promoting self-pollination - Genetic consequences of self-pollination - Mechanisms promoting cross-pollination - Genetic consequences of cross-pollination.
4. Genetic erosion - Extinction - Introgression - Germplasm/Genetic Resources - Components - Activities in germplasm collection - Centres of Origin - Law of homologous series - Centres of diversity - Types of centres of diversity.
5. Selection - Basic principles of selection - Basic characteristics and requirements of selection - Natural and Artificial selection - Selection Intensity - Selection Differential - Heritability (narrow and broad sense) - Selection Response (Universal Plant Breeder's equation) - Expected Genetic Advance.
6. Progeny test - Johannsen's pure line theory and its conclusions - Variation in pure lines - Characters of pure lines - Genetic basis of pure lines.

7. Hybridization - Objective and Aims - Types of hybridization - Procedure / steps involved in hybridization - Components of genetic variation - Additive, Dominance and Epistatic variance.
8. Self-incompatibility - Classification - Heteromorphic, Homomorphic, Gametophytic and Sporophytic systems of incompatibility - Advantages and disadvantages - Utilization in crop improvement.
9. Male sterility - Genetic, Cytoplasmic and Cytoplasmic Genetic Male Sterility - Inheritance and maintenance - Utilization of male sterile lines in hybrid seed production - Their advantages and disadvantages.
10. Heterosis - Brief history - Estimation of different types of heterosis (Average heterosis, Hetero beltiosis and Standard heterosis) - Hybrid vigour - Luxuriance - Heterosis in cross-pollinated and self-pollinated species - Manifestations/Effects of heterosis.
11. Genetic basis of heterosis - Dominance, over dominance and epistasis hypotheses - Objections and their explanations - Commercial utilization.
12. Inbreeding depression - Brief history - Effects of inbreeding - Degrees of inbreeding depression - Development of inbred lines.
13. Concepts of population genetics and Hardy - Weinberg Law - Hardy Weinberg Law - Factors affecting equilibrium frequencies in random mating populations.
14. Breeding methods classification - Domestication, Acclimatization and Plant introduction - Primary introduction and secondary introduction - Plant introduction agencies in India - National Bureau of Plant Genetic Resources (NBPGR) and its activities - Procedure of plant introduction - Merits and demerits of plant introduction.
15. Mass selection - Applications and procedures - Modification of mass selection - Merits, demerits and achievements. Pureline selection - Procedure - Merits, demerits and achievements - Comparison between mass and pure line selections.
16. Handling of segregating population - Pedigree method - Procedure - Merits, demerits and achievements.
17. Bulk method - Procedure - Merits, demerits and achievements - Comparison between pedigree and bulk methods - Single seed descent method - Merits and demerits.
18. Backcross method - Requirements and applications - Procedure for transfer of single dominant gene.
19. Backcross method - Procedure for transfer of single recessive gene - Merits, demerits and achievements - Comparison between pedigree and backcross methods - Multiline - Definition - Characteristics of multiline - Achievements.
20. Heterosis Breeding - History of hybrid varieties (maize, sorghum, bajra, sunflower, cotton and rice) - Exploitation of heterosis - Steps in production of single and double cross hybrids.
21. Composite and synthetic varieties - Production procedures - Merits, demerits and achievements - Factors determining the performance of synthetic varieties - Comparison between synthetics and composites.
22. Population Improvement methods –Selection without progeny testing (mass selection) - Selection with progeny testing (ear-to-row method and its modifications) - Merits and demerits of ear-to- row method - Achievements.
23. Selection with progeny testing - Recurrent selection - Different types - Detailed pro-

cedures - Conclusion on the efficiency of different recurrent selection schemes.

24. Breeding methods in asexually propagated crops - Characteristics of asexually propagated crops - Characteristics of clones - Clonal selection - Procedure (with and without hybridization) - Advantages and disadvantages - Problems in breeding asexually propagated crops - Genetic variation within clones - Achievements - Comparison among clones, purelines and inbreds.
25. Mutation breeding - Steps in mutation breeding - Applications - Limitations and achievements.
26. Polyploidy in relation to plant breeding - Autopolyploids - Morphological and cytological features - Applications in crop improvement - Limitations - Allopolyploidy - Morphological and cytological features - Applications in crop improvement - Limitations.
27. Wide hybridization - History – Barriers to produce distant hybrids - Techniques for production of distant hybrids - Applications of wide hybridization in crop improvement - Limitations - Achievements - Pre-breeding.
28. Biotic stress resistance - Disease resistance - Mechanisms - Genetic basis of disease resistance - Horizontal and vertical resistance - Gene for gene hypothesis - Sources of disease resistance - Breeding methods for disease resistance - Achievements.
29. Insect resistance - Mechanisms - Nature of insect resistance - Genetics of insect resistance - Sources of insect resistance - Breeding methods for insect resistance - Problems in breeding for insect resistance - Achievements.
30. Abiotic stress resistance - Drought resistance, Salt tolerance, Resistance to water logging, Heat stress resistance - Their Mechanisms of resistance / tolerance - Plant features associated with their resistance / tolerance - Sources of resistance / tolerance - Breeding methods - Limitations.
31. Participatory plant breeding - Definition - Goals – Methodology - Advantages and limitations - Varietal Release and Notification.
32. Intellectual Property Rights - Forms of IPRs - Criterion for Patenting - Plant Breeder's and Farmer's Rights.

Practicals

1. Plant Breeder's kit for hybridization.
2. Work out the mode of pollination in a given crop and extent of natural out crossing.
3. Floral structure, emasculation and hybridization techniques in self-pollinated crops - rice, groundnut.
4. Floral structure, emasculation and hybridization techniques in self-pollinated crops - green gram, sesame.
5. Floral structure, emasculation and hybridization techniques in cross-pollinated crops - maize, castor.
6. Floral structure, emasculation and hybridization techniques in often cross - pollinated crops - cotton, red gram.
7. Study of germplasm of various crops.
8. Study of male sterility systems.
9. Handling of segregating populations.
10. Consequences of inbreeding on genetic structure of resulting populations.
11. Estimation of heterosis and inbreeding depression.
12. Prediction of performance of double cross hybrids.
13. Screening tests for biotic and abiotic stresses.

14. Designs and layouts of field experiments used in plant breeding.
15. Mean, range, variance, standard deviation and analysis of Randomized Block Design.
16. Maintenance of breeding records and data collection.

Suggested Readings

1. Principles of Plant Breeding (1st & 2nd Edition) by RW Allard.
2. Plant Breeding: Principles & Practices by JR Sharma.
3. PlantBreeding- B.D.Singh.
4. Principles and Procedures of Plant Breeding - Biotechnical and Conventional approaches By GSChahal and SS Gosal.
5. Principles of Plant Genetic sand Breeding by George Acquaah.

GPBR 311
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

Course Outlines

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oil-seeds; 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, pearlmillet and pigeopea 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, pigeopea, urdbean, mungbean, soybean, groundnut, sesame, castor, cotton, cowpea, tabacco, brinjal, okra and cucurbitaceous crops. Maintenance breeding of different kharif crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seed production in kharif crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

Lecture Outlines

Theory

1. Concepts of breeding self–pollinated, cross–pollinated and vegetatively propagated

crops - Plant genetic resources, its utilization and conservation.

2. Cereals - Rice - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
3. Millets - Pearl millet, Fingermillet, Kodomillet and Prosomillet - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
4. Pulses - Pigeonpea - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
5. Pulses - Urdbean and Mungbean - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
6. Oilseeds - Soyabean and Groundnut - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
7. Oilseeds - Sesame and Castor - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
8. Fodder crops - Cowpea and Horsegram - Origin - Distribution of species - Wild relatives - genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
9. Fibre crops - Jute and Cotton - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
10. Cash crops - Tobacco - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
11. Vegetable crops - Brinjal and Okra - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
12. Vegetable crops - Cucurbitaceous crops - Cucumber and Watermelon - Origin - Distribution of species - Wild relatives - genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
13. Horticultural crops - Banana and Guava - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) -

Seed production technology.

14. Horticultural crops - Lime, Lemon and Apple - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
15. Flower crops - Chrysanthemum and Marigold - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
16. Ideotype concepts - Climate resilient crop varieties for multiple stresses in kharif crops- achievements.

Practicals

1. Floral biology, emasculation and hybridization techniques in Rice and Pearl Millet.
2. Floral biology, emasculation and hybridization techniques in Finger millet, Kodo millet and Prosomillet.
3. Floral biology, emasculation and hybridization techniques in Pigeonpea, Urdbean and Mungbean.
4. Floral biology, emasculation and hybridization techniques in Soybean, Groundnut, Sesame and Castor.
5. Floral biology, emasculation and hybridization techniques in Cowpea and Horsegram.
6. Floral biology, emasculation and hybridization techniques in Cotton, Jute and Tobacco.
7. Floral biology, emasculation and hybridization techniques in Brinjal and Okra.
8. Floral biology, emasculation and hybridization techniques in Cucumber and Water-melon.
9. Floral biology, emasculation and hybridization techniques in Banana and Guava.
10. Floral biology, emasculation and hybridization techniques in Lime, Lemon and Apple.
11. Floral biology, emasculation and hybridization techniques in Chrysanthemum and Marigold.
12. Handling of germplasm and segregating populations by different methods - pedigree, bulk and single seed decent methods.
13. Study of field techniques for Varietal and hybrid seed production in kharif crops.
14. Study of important quality characters and donor parents for important characters in kharif crops
15. Visit to seed production plots.
16. 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

GPBR 312
FUNDAMENTALS OF AGRICULTURAL BIOTECHNOLOGY
3 (2+1)

Objectives

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

Course Outlines

Theory

Introduction to Plant Tissue Culture and Genetic Engineering: History; Cellular totipotency and cyto differentiation; Callus culture, Single-cell/suspension culture and their applications; Organogenesis and somatic embryogenes is ; Somaclonal variation and its use in crop improvement; Embryo rescue technique and its significance in hybrid development; Invitro 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 (Genegun 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.

Lecture Outlines

Theory

1 Introduction to Plant Tissue Culture - definitions - origin - history - major con cepts and new technologies - importance - International organizations

	biotechnology in India.
2	Cellular totipotency and cyto-differentiation - morphogenesis - growth and differentiation in cultures - types of cultures - Callus culture, Single-cell/sus pension culture - applications.
3	Organogenesis and somatic embryogenesis - stages of somatic embryo devel opment -general procedure - factors affecting somatic embryogenesis - appli cations - limitations.
4	Artificial/synthetic seed production - desiccated systems and hydrated sys tems of synthetic seed production - advantages and limitations - Applications.
5	Embryo culture - Embryo rescue technique - purpose–methods of embryo cul ture - procedure - significance in hybrid development - applications - achieve ments.
6	*Invitro* pollination and *Invitro* fertilization- factors affecting invitro pollination - significance in hybrid development - ovary culture - significance - ovary culture - significance.
7	Protoplast culture - methods of protoplast isolation- culture of protoplasts - regeneration.
8	Somatic hybridization - procedure -fusion of protoplasts-selection and culture of somatic hybrid cells-regeneration-symmetric hybrids, asymmetric hybrids and cybrids - advantages and limitations - Application in crop improvement.
9	Anther/pollen culture - brief procedure - factors affecting and rogenesis - applications of haploids in crop improvement - limitations - achievements.
10	Somaclonal variation - types–origin- advantages - limitations - applications in crop improvement.
11	Micropropagation- generation of quality planting material - Development of disease free (virus free) plants through apical meristem culture - procedure - various approaches for shoot multiplication advantages and limitations - applications.
12	Secondary metabolite production - Importance - Use of cell, suspension, organ, hairy roots, shoot and callus in metabolite production - Applications - Problems associated with secondary metabolite production.
13	In vitro germplasm conservation - slow growth and cryo preservation - Achievements – Applications - Limitations.
14&15	National certification and Quality management of TC plants - Introduction and background of NCS- TCP - Structure - Roles and Responsibility - NCS-TCP Man agement Cell (NMC) - Accreditation Panel Accredited Test Laboratories (ATLs) - Recognized Tissue Culture Production Facility - Certification of Tissue Cul ture Raised Plants - Tissue Culture Certification Standards.
16	Introduction to Molecular Biology - Definition - components - Three domains of life (Eukaryotic, Prokaryotic and Archea) - Molecular organization of cell.
17	Structure of prokaryotic and eukaryotic gene - Plant gene structure as discon tinuous gene - Control sequences - TATA box - AGGA box- Other regulatory ele ments.
18	Central dogma of life - Post transcriptional and Post-translational modifica tions.
19	Nucleic acid hybridization - Polymerase chain reaction PCR - Components in a polymerase chain reaction.

20 Inverse PCR Reverse transcriptase mediated PCR (RT-PCR) - Quantitative RT-PCR -Advantages - Problems - Applications
21 DNA sequencing – Sanger method – NGS - Advantages.
22&23 Introduction to markers - Morphological, biochemical and molecular markers - Advantages and disadvantages - ideal Marker system - RFLP, RAPD, SSR, SNP
24&25 Marker-assisted breeding in crop improvement - Genome - Omics.
26&27 Introduction to recombinant DNA technology and Genetic Engineering- History - Applications in different fields - Advantages - Limitations / Apprehensions - Strategies for resistance management - DNA modifying enzymes - Gene cloning.
28 Vectors - Ideal vector - Plasmids, cosmids, Phagemids, Bacteriophages, BAC and YAC - characteristics - advantages - disadvantages - Gene cassette.
29 Direct plant genetic transformation - physical (Gene gun method) and chemical (PEG mediated) methods.
30 Indirect gene transfer methods - Agrobacterium mediated gene transfer - TDNA - disarming - Virgenes - co-cultivation - Selection of tranformants.
31 Transgenic crops - importance - Bt Cotton, herbicide resistance, Flavr-savr tomato, Golden rice, Barnase - Barstar system of male sterility.
32 Biosafety - Risk to human health, environment etc. - Containment - Biosafety levels- confinement - National Biosafety Regulatory frame work in India - Recombinant DNA safety Guidelines - Socio- economic and ethical considerations - International protocols and conventions on biosafety.

Practicals

1 Introduction to Plant Tissue Culture Laboratory and Good Laboratory Practices
2 Media Preparation and sterilization - Glassware and explant sterilization
3&4 Micropropagation and Apical meristem culture
5&6 Callus induction and culture.
7&8 Anther culture.
9&10 Preparation of synthetic seeds.
11&12 Isolation of plasmid DNA - Quantification of DNA-Agarose Gel Electrophoresis and visualization of plasmid DNA.
13 Restriction digestion of plasmid DNA and Agarose gel electrophoresis.
14 Isolation of Plant genomic DNA.
15 PCR amplification of DNA and confirmation of amplicons.
16 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 Publishers
3. Christou P and Klee H. 2004. Hand book 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 Publishers.

GPBR 313
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 originand distribution of rabi crops
3. To design breeding objectives of major rabicrops
4. To impart information on different crop varieties for rabiseason

Course Outlines

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oil-seeds; 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 objectivesand procedures including conventional and modern innovative approaches fo 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, rape seed and mustard etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Botany of crops, Floral biology, emasculation and hybridization techniques in different crops pecies, 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.

Lecture Outlines

Theory

1. Concepts of breeding, self - Pollinated, cross - Pollinated and vegetatively propagated crops - Plant genetic resources, its utilization and conservation.
2. Cereals - Wheat, Barley and Oat - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
3. Millets - Maize and Sorghum - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
4. Pulses - Chickpea and Lentil - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
5. Oilseeds - Sunflower, Safflower and Linseed - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) -

Seed production technology.

6. Oilseeds - Rapeseed and Mustard - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
7. Sugars and Starches - Potato - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
8. Sugars and Starches - Sweet Potato - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
9. Sugars and Starches - Sugarcane - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
10. Vegetable crops - Tomato and Chilli - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
11. Vegetable crops - Onion and Garlic - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
12. Vegetable crops - Cabbage and Cauliflower - Origin - Distribution of species - wild relatives - genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
13. Horticultural crops - Mango and Papaya - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
14. Horticultural crops - Pomegranate and Sapota - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major reeding procedures (conventional and modern innovative approaches)- Seed production technology.
15. Flower crops - Rose and Jasmine - Origin - Distribution of species - Wild relatives - Genetics of qualitative and quantitative characters - Breeding objectives - Major breeding procedures (conventional and modern innovative approaches) - Seed production technology.
16. Ideotype concepts – Climate resilient crop varieties for multiple stresses in rabi crops – Achievements.

Practicals

1. Floral biology, emasculation and hybridization techniques in Wheat, Oat and Barley.
2. Floral biology, emasculation and hybridization techniques in Chickpea and Lentil.
3. Floral biology, emasculation and hybridization techniques in Sunflower, Safflower

and Linseed.
4. Floral biology, emasculation and hybridization techniques in Rapeseed and Mustard.
5. Floral biology, emasculation and hybridization techniques in Potato and Sweet Potato.
6. Floral biology, emasculation and hybridization techniques in Sugarcane.
7. Floral biology, emasculation and hybridization techniques in Tomato and Chilli.
8. Floral biology, emasculation and hybridization techniques in Onion and Garlic.
9. Floral biology, emasculation and hybridization techniques in Mango and Papaya.
10. Floral biology, emasculation and hybridization techniques in Pomegranate and Sapota.
11. Floral biology, emasculation and hybridization techniques in Rose and Jasmine.
12. Handling of germplasm and segregating populations by different methods-pedigree, bulk and single seed descent methods.
13. Study of field techniques for varietal and hybrid seed production in rabi crops.
14. Study of important quality characters and donor parents for important characters in rabi crops.
15. Visit to seed production plots.
16. 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 FieldCrops 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

GPBR 314
FUNDAMENTALS OF SEED SCIENCE & TECHNOLOGY
2 (1+1)

Objectives

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

Course Outlines

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 procedure, 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.

Lecture Outlines

Theory

1. Introduction to seed and seed technology - Definitions and importance - Roles and goals of seed technology.
2. Seed quality-Definition, Characters of good quality seed.
3. Causes of deterioration of varietal purity and assessment of genetic purity - Safeguards for maintenance of genetic purity.
4. Different classes of seed - Nucleus Seed - Breeder Seed - Foundation Seed - Certified Seed - Truthfully labeled Seed.
5. Seed certification - History of seed certification - procedure for seed certification and Field inspection- Recognition of Seed certification Agencies of foreign countries.
6. Seed Act - Main features of the Seed Act, 1966 and Seed Act enforcement - Duty and powers of seed inspector-Offences and penalties-. Seeds Control Order 1983 & New Seed Bill 2019.
7. Basics of seed quality testing - Seed testing - Objectives of seed testing - International Seed Testing Association (ISTA) and - establishment of Seed Testing Laboratory (STL) - Seed testing procedures for quality assessment & seed quality enhancement techniques.
8. Foundation and certified seed production of varieties and hybrids in Rice.
9. Foundation and certified seed production of varieties and hybrids in Maize.
10. Foundation and certified seed production of varieties and hybrids in Sorghum.
11. Foundation and certified seed production of varieties in Blackgram, Greengram and Bengalgram - varieties and hybrids in Redgram.
12. Foundation and certified seed production of varieties in Groundnut and Sesamum varieties & hybrids in sunflower.
13. Seed drying - Methods of seed drying - Sun drying - Forced air drying - Principle of forced air drying - Moisture equilibrium between seed and air.
14. Planning, layout and establishment of seed processing plant - Factors to be considered in planning and designing a seed processing plant - Types of layouts - sequence of operations.
15. Seed treatment, its importance - Types of seed treatment and their benefits and method of application - Seed packaging.
16. Seed storage - Factors affecting seed longevity in storage and conditions required for good storage.

Practicals

1. Seed structure Seed production in cereals (Wheat, Rice, Maize, Sorghum and Bajra)
2. Seed sampling - Principles and procedures

3. Physical Purity analysis of field crops and vegetable crops
4. Seed moisture tests of field crops and vegetable corps
5. Germination test of field crops and vegetable crops
6. Seed vigour tests of field crops and vegetable crops
7. Seed viability test of field crops and vegetable crops
8. Grow Out Test (GOT)
9. Field Inspection
10. Seed health testing using blotter and agar plate method
11. Visit to seed production farm
12. Visit to Seed Testing Laboratories (STLs)
13. Visit to seed processing plant
14. Visit to Seed Certification Agency
15. Visit to public sector seed production agencies
16. Visit to seed storage godowns

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.

SEC III
SEED PRODUCTION AND TESTING TECHNOLOGY
2 (0+2)

Objectives:

1. To provide knowledge on concepts and importance of seed production technology.
2. To impart skills on varietal and hybrid seed production techniques in major crops.
3. To educate about seed testing for quality seed production.
4. To impart practical skills by arranging visits to various seed production fields, seed industries, seed testing labs, seed processing plants, seed storage godowns etc.

Practicals

1. Study of floral biology of angiospermic plants.
2. Study of modes of reproduction - Sporogenesis - Gametogenesis.
3. Study of modes of pollination - Self pollination - Cross pollination - Often cross pollination.
4. Breeding tools for hybrid seed production - Breeders Kit-emasculation and pollination techniques.
5. Seed production vs Crop production.
6. Types of seed production - Varietal & Hybrid seed production

7. Structure of seed industry in India - Formal and informal systems - Seed supply chain.
8. Agronomic principles of seed production.
9. Genetic principles of seed production.
10. General steps involved in production of quality seed.
11. Classes of seed and generation system of seed multiplication.
12. Hybrid Seed - Methods of development of hybrids; use of male sterility and self-incompatibility and CHAs in hybrid seed production.
13. Planting design for hybrid seed production - rice, maize, pearl millet, cotton, red gram, sunflower.
14. Study on methods of achieving synchronization in flowering and practicing supplementary pollination.
15. Practicing roguing operation - identification of off-types, pollen shedders, shedding tassels, partials, selfed bolls.
16. Methods and techniques of seed production in varieties and hybrids of rice.
17. Methods and techniques of seed production in varieties and hybrids of maize.
18. Varietal and hybrid seed production in pulses - Red gram
19. Varietal and hybrid seed production in oil seeds - Sunflower.
20. Varietal and hybrid seed production in fibre crops - Cotton.
21. Hybrid seed production techniques in vegetables - Tomato, Chillies, Brinjal.
22. Seed production planning and economics of seed production - Varieties
23. Seed production planning and economics of seed production - Hybrids.
24. Layout of seed testing laboratory, identification and hadling of instruments used in seed testing laboratory.
25. Preparation of seed album and identification of seeds.
26. Visit to seed production fields.
27. Visit to public sector seed industry
28. Visit to private sector seed industry.
29. Visit to seed testing laboratory.
30. Visit to seed processing plant.
31. Visit to seed certification agency.
32. Visit to seed storage godowns.

Suggested Readings

1. Malavika Dadlani and Devendra K. Yadava. 2023. Seed Science and Technology Biology, Production, Quality,Springer, Singapore.
2. Agarwal R L. 2021. Seed Technology, Oxford and IBH Publication Co., New Delhi.
3. Singhal NC. 2010. Seed Science and technology,Kalyani Publishers, New Delhi
4. Dhirendra Khare and Mohan S. Bhale. 2007. Seed Technology, Scientific Publishers (India), Jodhpur
5. Singhal NC. 2003. Hybrid Seed Production in Field crops, Kalyani Publishers, New Delhi
6. Copeland, L.O and McDonald, MB. 2001. Principles of Seed Science and technology
7. Kluwer Academic Publishers, USA
8. Agarwal P K and Dadlani M 1986. Techniques in seed science and Technology, South Asian Publishers, New Delhi.
9. Agarwal P K 1994. Principles of Seed technology, ICAR, New Delhi.

ELCT 411
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, pearlmillet, sorghum, pigeonpea, chickpea, greengram, blackgram, 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

Course Outlines

Theory

Types of crops and modes of plant reproduction. Line development and maintenance breeding in self and cross pollinated crops (A/B/Rand 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-through put pheno typing 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 verities 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 inhybrid 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.

Lecture Outlines

Theory

1. Types of crops and modes of reproduction in plants.
2. Different types of seeds - Classification.
3. Line development.
4. Development of hybrids in self and cross pollinated crops using three line (A/B/R lines).
5. Development of hybrids in self and cross pollinated crops using two line sys-

tem.

6. Principles and techniques of seed production.
7. Seed production in self pollinated crops.
8. Seed production in cross pollinated crops.
9. Seed production in often-cross pollinated crops.
10. Maintenance breeding in self pollinated crops.
11. Maintenance breeding in cross pollinated crops.
12. Genetic purity test of commercial hybrid.
13. Advances in hybrid seed production of rice.
14. Advances in hybrid seed production of maize.
15. Advances in hybrid seed production of sorghum.
16. Advances in hybrid seed production of pearl millet.
17. Advances in hybrid seed production of castor.
18. Advances in hybrid seed production of sunflower.
19. Advances in hybrid seed production of cotton.
20. Advances in hybrid seed production of pigeonpea.
21. Advances in hybrid seed production of brassica sps.
22. Quality seed production of vegetable crops under open and protected environ ment.

23-26 Alternative strategies for the development of the line cultivars - Cytological, haploid inducer, tissue culture technique and biotechnological tools.

27. Variety testing, release and notification systems in India - SVRC.
28. Variety testing, release and notification systems in India - CVRC.
29. IPR issues in commercial plant breeding.
30. DUS testing & Registration of varieties under PPV and FR Act.
31. DUS Descriptors and testing in rice
32. DUS Descriptors and testing in groundnut
33. DUS Descriptors and testing in maize.
34. DUS Descriptors and testing in sorghum
35. DUS Descriptors and testing in pearl millet
36. DUS Descriptors and testing in castor.
37. DUS Descriptors and testing in sunflower
38. DUS Descriptors and testing in cotton
39. DUS Descriptors and testing in pigeonpea.
40. DUS Descriptors and testing in rapeseed and mustard.
41. DUS Descriptors and testing in brinjal.
42. DUS Descriptors and testing in tomato.
43. Quality testing in self pollinated crops.
44. Quality testing in cross pollinated crops.
45. Speed Breeding.
46. Breeding Management Systems.
47. High-throughput phenotyping platforms.
48. High-throughput genotyping platforms

Practicals

1. Floral biology, selfing and crossing techniques in self pollinated species - rice, groundnut
2. Floral biology, selfing and crossing techniques in cross pollinated species - maize/

castor
3. Floral biology, selfing and crossing techniques in often cross pollinated species redgram/cotton.
4. Techniques of seed production in self pollinated crops using three line (A/B/R lines) and two line systems in self and cross pollinated crops.
5. Understanding the difficulties in hybrid seed production.
6. Tools and techniques for optimizing hybrid seed production
7. Concept of rouging in seed production plot.
8. Concept of line, its multiplication and purification in hybrid seed production.
9. Role of pollinators in hybrid seed production.
10. Hybrid seed production techniques in rice, sorghum, pearl millet and sunflower crops.
11. Hybrid seed production techniques in maize, castor, pigeon pea and cotton crops.
12. Hybrid seed production techniques in rapeseed-mustard and vegetable crops.
13. Sampling and analytical procedures for purity testing and detection of spurious seed.
14. Seed drying and storage structure in quality seed management.
15. Screening techniques during seed processing, viz., grading and packaging.
16. 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, 160pp.
6. Breeding and Crop Production: H. Padmalatha, Random.
7. Biotechnology for Agricultural Breeding: Mangal, S. K. GeneTech Books.

ELCT 412
BIOTECHNOLOGY OF CROP IMPROVEMENT
4 (3+1)

Objectives

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

Course Outlines

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 andlimitations, utility in the improvement of crop plants. Direct and Indirect methods of gene transferin plants - Agrobacterium- Mediated gene transfer in dicots and monocots; Direct DNA delivery methods (microinjection, particle gun method, electroporation); gene targeting; Gene silencing techniques; introductionto 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; Applicationsof 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.

Lecture Outlines

Theory

1 Biotechnology - Impact on crop improvement - Nutrient and Food security - the perspective of society - Political stability and market restructuring.

2 Biotechnological techniques available for crop improvement - Plant tissue culture - Genetic engineering - Genome editing - Molecular marker technology (MAS) - Genomic selection - Scope and importance.

3 Plant tissue culture - Somaclonal variation - types - origin - applications - advantages - limitations - use in crop improvement.

4 Plant tissue culture - Embryo culture - Embryo rescue technique - purpose - applications - achievements.

5 Anther / pollen culture - brief procedure - factors affecting androgenesis - Applications of haploids in crop improvement - limitations - achievements.

6 Organogenesis and somatic embryogenesis - stages of somatic embryo devel opment - general procedure - factors affecting somatic embryogenesis - appli cations - limitations.

7 Protoplast culture - methods of protoplast isolation - culture of protoplasts - regeneration.

8 Somatic hybridization - procedure - fusion of protoplasts - selection and culture of somatic hybrid cells - regeneration of hybrid plants - symmetric hybrids, asymmetric hybrids and cybrids - advantages and limitations of somatic hybridization - Application in crop improvement.

9	Artificial/ synthetic seed production - Desiccated systems and hydrated sys tems of synthetic seed production - advantages and limitations - Applications.
10	Genetic engineering - Creation of transgenic plants - Gene cloning - Steps in transgenic development.
11	Transgenic crops - Applications - Advantages and disadvantages - Ethical issues - IPRs - World scenario on GM Crops.
12	Genetic engineering - Gene transfer - Direct methods in plants - Micro injection, particle gun method and electroporation - advantages and disadvantages
13	Gene transfer - Agrobacterium-mediated gene transfer in dicots and mono cots - Advantages and disadvantages.
14	Transgenic crops - importance - Bt Cotton, herbicide resistance, Flavr-saver tomato, Golden rice, Barnase – Barstar system of male sterility.
15	Biosafety - risks with genetically modified organisms- International convetion - International regulations - Indian regulatory mechanism - Application in Agricultural Biotechnology.
16&17	Gene targeting - Steps - Construct preparation - Targeting the gene - Genera tion - Types of disruption - Applications
18-20	Gene silencing - Types - Transcriptional - Post transcriptional - Role in plants - Advantages and disadvantages.
21&22	siRNA - importance - Classes - biogenesis - Functions of plant siRNAs.
23&24 -	miRNA - Importance -Techniques for Determining miRNA Functions in Plants - Applications - Differences between siRNA and miRNA.
25&26	RNAi - Importance - Molecular cloning - Construction of negative control vec tors -Construction of shRNA/miRNA expression vectors - Construction of miR NA expression vectors - Western blotting.
27&28	Genome editing - Importance - Targeted nucleases - Restriction enzymes - ZFN - TALENs - CRISPR - Cas9 -Base editing - Prime editing.
29&30	CRISPR/Cas9 - Construction of donor and destination vectors - Construction of expression clones - Plant transformation – Genotype analysis.
31&32	CRISPR- Cas9 - CRISPR sgRNA design and DNA constructs - Cell culture and electroporation - Viability and albumin assays - Measuring allele alterations using Tracking of Indels – Confirmation.
33	*In vitro synthesis* of single guide RNA (sgRNA) - Steps - Factors affecting syn thesis.
34	Cas9/sgRNA complexes to test for activity on DNA substrates - Features of complexes - Methods to know the activity.
35	CRISPR-Cas9 - Validating CRISPR/Cas9- Mediated Gene Editing - T7 endonu clease 1 (T7E1) assay - Steps - Advantages and disadvantages.
36&37	Crispr-Cas9 - Validating Crispr/Cas9-Mediated Gene Editing - Sequencing -Based Methods For CRISPR Validation - Sanger Sequencing and Tracking of Indels By Decomposition (TIDE)- Next Generation Sequencing (NGS) - Confirming Loss of Expression.
38	CRISPR- Cas9 - Applications in crop plants.
39	Regulation of Genome edited crops in India - Regulatory mechanism.
40	Markers- Morphological and Biochemical Markers.
41&42	Molecular markers-PCR based-Non-PCR based - Advantages and disadvantages.

43 Molecular markers - Applications.
44&45 Molecular markers - Marker assisted selection - Marker assisted backcross breeding - Steps - Applications - Examples.
46-48 Genomic selection - Importance - Different populations - Procedure - Advan tages and disadvantages.

Practicals

1. Plant DNA extraction by CTAB method.
2. Plasmid extraction from bacteria
3. Polymerase chain reaction.
4. Gel electrophoresis.
5. Poly acrylamide gel electrophoresis.
6. Agrobacterium-mediated transformation in Tobacco - Preparation of construct.
7. Agrobacterium-mediated transformation in Tobacco - Transfer to binary vector.
8. Agrobacterium-mediated transformation in Tobacco - Transformation of Agrobacterium
9. Agrobacterium-mediated transformation in Tobacco - Prepare explants - Inoculation and Co- cultivation.
10. Agrobacterium-mediated transformation in Tobacco - Antibiotic based selection of putative transformants.
11. Agrobacterium-mediated transformation in Tobacco - Validation using PCR.
12. Genome editing-preparation of CRISPR/Cas construct.
13. Genome editing-Direct transfer to plant.
14. Genome editing-analysis of the targets.
15. Planning of a Marker Assisted Backcross Breeding programme - Selection of parents, crossing strategy.
16. Foreground, background and recombinant selection using markers.

Suggested readings

1. Old, R.W., Primrose, S.B & Twyman, R.M. 2001. Principles of Gene Manipulation and Genomics. 7th Edition. Oxford & Black Well Scientific Publications.
2. Green, M.R & Sambrook, J. 2012. Molecular Cloning: A Laboratory Manual. Cold Spring Harbor, NY
3. Brown, T.A. 2006. Genomes. (3rd ed.). Garland Science Pub., New York
4. Sander JD and Joung JK. 2014. CRISPR-Cas systems for Editing, Regulating and Targeting Genomes.
5. Gene Cloning and DNA Analysis. 2010. Retrieved from http://biolab.szu.edu.cn/otherweb/lzc/ genetic.
6. Pranav Kumar and Usha Mina. 2015. Biotechnology: A Problem Approach. Pathfinder Publication
7. K.H. Singh, Ajay Kumar and Nehanjali Parmar. 2019. Agricultural Biotechnology At a Glance
8. Hari Har Ram. 2019. Crop Breeding and Biotechnology. Kalyani Publications
9. S.C. Rastogi, 2020. Biotechnology: Principles and Applications. Narosa Publishers
10. Slater, 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford, 400p.

ELCT 413
COMMERCIAL SEED PRODUCTION
4 (3+1)

Objectives

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

Course Outlinse

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

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

Practical

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate. Operation and handling of mechanical drying equipment; effect of drying temperature and duration on seed germination and storability seed processing equipment; seed treating equipment.

Seed production in cross pollinated crops with special reference to land, isolation, Planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in tomato, Hybrid seed production in Maize, detasseling in maize, identification of rogues and pollen shedders, Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc., Visit to seed processing plant and commercial controlled and uncontrolled Seed Stores, Seed industries and local entrepreneurships visit to nearby areas, Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage, detection of seed-borne fungi, bacteria and viruses, identification of storage fungi, control of 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.

Lecture Outlines

Theory

1. General Principles of Seed Production: Introduction to seed and seed technology - Definition of variety - Type of variety (Pureline variety, Line variety, Multiline variety, Varietal blend, Inbred line, Hybrid, Population and Clonal Crops) and their genetic constitution.
2. Seed quality - Definition, Characters of good quality seed/improved seed - Different classes of seed - Nucleus seed, Breeder seed, Foundation seed, Certified seed and Truthfully labelled seed.
3. Deterioration of crop varietal purity - Factors responsible for loss of genetic purity - Assessment of genetic purity - Safeguards for maintenance of genetic purity.
4. Agronomic principles of seed production - Selection of a suitable agro-climatic region, land and variety - Raising of crops.
5. Importance of isolation distance and roguing- Space isolation, time isolation and barrier isolation Roguing.
6. Apomixis - Classification - Applications - Advantages and disadvantages.
7. Male sterility - Classification - Applications - Advantages and disadvantages.
8. Self-incompatibility - Classification - Applications - Advantages and disadvantages.
9. Seed certification: History, Concept, Objectives and Procedure of seed certification - Procurement of a class of improved seeds - Reporting to monitoring or certification Agency.
10. 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.
11. Principles and practices of seed production of field crops - Rice.

12. Principles and practices of seed production of field crops - Wheat.
13. Principles and practices of seed production of field crops - Maize.
14. Principles and practices of seed production of field crops - Sorghum.
15. Principles and practices of seed production of field crops - Bajra.
16. Principles and practices of seed production of field crops - Redgram & Bengal Gram.
17. Principles and practices of seed production of field crops - Groundnut.
18. Principles and practices of seed production of field crops - Sunflower.
19. Principles and practices of seed production of field crops - Castor.
20. Principles and practices of seed production of field crops - Cotton
21. Principles and practices of seed production of horticultural crops - Tomato.
22. Principles and practices of seed production of horticultural crops - Brinjal
23. Principles and practices of seed production of horticultural crops - Hot & Sweet Pepper.
24. Principles and practices of seed production of horticultural crops - Okra.
25. Principles and practices of seed production of horticultural crops - Onion.
26. Principles and practices of seed production of horticultural crops - Cucumber.
27. Principles and practices of seed production of horticultural crops - Cabbage & Cauliflower.
28. Principles and practices of seed production of horticultural crops - Carrot.
29. Principles and practices of seed production of horticultural crops - Potato.
30. Farmers participatory seed production- Concept- Advantages-Challenges.
31. General Principles of Seed Processing: Introduction-Objectives of Seed Processing, Planning, layout and establishment of seed processing plant - Factors to be considered in planning and designing a seed processing plant.
32. Seed Drying- Principle - Water vapour equilibrium - Methods of drying seeds - Sun drying - Forced air drying.
33. Seed cleaning - Pre cleaning and preconditioning equipments - Principle and method of seed cleaning - Air screen machine - Principle of cleaning - Parts of air screen cleaner.
34. Upgrading the quality of cleaned seeds - Different upgrading machines - Dimensional separators, Density separators, Surface texture separators, Colour separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids - Their principles of operation and uses.
35. Seed treatment - Temperature treatment, Chemical treatment - method of application - Equipments used for seed treatment - Bagging of seed and labelling.
36. General Principles of Seed Testing: Seed testing-Introduction- Procedure of Seed testing- Components of seed quality testing - Genetic, physical, physiological and seed health testing.
37. Seed sampling- Types of seed sampling- Requirements of sampling - Sampling Procedures.
38. Seed viability and vigour - Concepts- Tests.
39. Seed Dormancy - Types - Principles - Physiological quality of seed - Methods to overcome seed dormancy.
40. Seed Germination - Types of germination - Biochemical and genetic basis.
41. Seed Industry and Seed Marketing: Introduction - Evolution of the seed industry - Development of the vegetable and Flower seed industry.
42. Seed marketing - Concept - Definition and purpose - Importance and promotion of

quality seed - formal and informal seed supply systems.

43. Seed marketing intelligence and product mix - Sales promotion-Distribution channels - Marketing costs and margins - Packaging and labelling- Seed Associations.
44. 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) and seed multiplication ratio (SMR).
45. 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.
46. Biotechnology in Seed Technology: History of plant tissue culture - Laboratory organization - Composition of nutrient medium.
47. Micro-propagation, Axillary bud proliferation approach - Meristem and shoot tip culture, Bud culture, Advantages of Micro - propagation, Problems associated with micro-propagation.
48. 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.

Practicals

1. Planning of seed production of different seed classes in field crops.
2. Operation and handling of seed drying, seed processing and seed treating equipment.
3. Hybrid seed production in Rice
4. Hybrid seed production in Maize and Bajra.
5. Hybrid seed production in Tomato, Chilli and Okra.
6. Visit to seed production plots.
7. Visit to seed processing plant/Commercial controlled and uncontrolled seed stores.
8. Visit to seed industries and local entrepreneurships.
9. Seed health testing of field crops and vegetable crops.
10. Seed treatment methods.
11. Maintenance of aseptic conditions and sterilization techniques.
12. Preparation of nutrient stocks for synthetic media.
13. Preparation of MS medium for micro-propagation and callus induction.
14. Selection and inoculation of explant for micro-propagation and callus induction.
15. Hardening and Acclimatization procedures for field and horticultural crops.
16. Synthetic seed preparation.

Suggested readings

1. Agarwal, R.L. 1997. Seed Technology. 2ndedn. 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.

SOIL SCIENCE

SSAC 121
FUNDAMENTALS OF SOIL SCIENCE
3 (2+1)

Objective

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

Course Outlines

Theory

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

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.

Lecture Outlines

Theory

1. Soil pedological and edophological concepts - Introduction - Spheres of the earth atmosphere, hydrosphere and lithosphere - Their characteristics - Origin of soil - Soil and soil components - Mineral matter, organic matter, water and air - Definition of soil and various concepts of soil - Branches of soil science
2. Rocks - Classification of rocks based on mode of origin and formation - Igneous rocks, sedimentary rocks and metamorphic rocks - Classification of rocks based on silica content - Weather ability of rocks
3. Minerals - Primary, secondary, essential and accessory minerals - Primary minerals - Quartz, feldspar, micas, pyroxenes, amphiboles and olivines - Weather ability of primary minerals
4. Secondary minerals- Non-silicate minerals - P, Ca, Mg, S and micronutrient containing minerals - Secondary silicate minerals – Basic structural units
5. Weathering - Types of weathering - Physical weathering of rocks - Agents of physical weathering and their role - Biological weathering - Role of flora and fauna in weathering process
6. Chemical weathering - Solution, hydration, hydrolysis, carbonation, oxidation and reduction
7. Soil formation - Soil forming factors - Classification - Climate, biosphere, parent material, topography, time and their role in soil formation - Catena - Definition
8. Pedogenic processes - Basic processes (gains, losses, transformation and trans-

locations) - Fundamental pedogenic processes, eluviation, illuviation, humification - Specific pedogenic processes - Calcification, decalcification, laterization, podzolisation, gleization, salinization, desalinization, alkalization, dealkalization and pedoturbation

9. Soil profile - Detailed description of a theoretical soil profile - Differences between surface soil and sub soil
10. Soil physical properties - Soil texture - Definition - Various inorganic components in soil and their properties - Various textural classes in soil and their properties
11. Particle size analysis - Stoke's Law - Assumptions and limitations - Significance of soil texture
12. Soil structure - Classification - Types, classes and grades of soil structure – Formation of soil structure - Importance of soil structure and its management
13. Density of soil - Bulk density and particle density - Factors affecting density parameters - Importance of bulk density of soil - Soil compaction - Its importance - Calculation of porosity
14. Soil consistence - Consistence of wet and dry soils - Soil crusting - Soil plasticity - Atterberg's plastic limits – Factors affecting plastic limits - Significance of soil consistence
15. Soil strength and its importance - Soil colour - Components - Significance of soil colour
16. Soil temperature - Sources of heat - Heat capacity and conductivity - Factors influencing soil temperature - Modification of soil thermal regimes - Measurement of soil temperature - Importance of soil temperature on crop growth - Management of soil temperature and importance
17. Soil air - Compositions of atmospheric air and soil air - Gaseous exchange - Influence of soil air on plant growth, soil properties and nutrient availability - ODR, measurement of oxygen diffusion rate - Measures to improve soil aeration
18. Soil water - Forces of soil water retention - pF concept - Soil moisture characteristic curves - Importance of soil water
19. Soil water potential - Components of water potentials - Soil moisture constants - Field capacity, wilting coefficient, hygroscopic water and saturation - Available water and methods for determining soil moisture constants - Pressure plate and pressure membrane apparatus
20. Water content - Soil water movement - Darcy's Law - Saturated, unsaturated and vapour flows - Infiltration, percolation and permeability - Distribution of water in profile in different soils - Soil drainage and its importance
21. Soil reaction, pH, soil acidity and alkalinity, buffering capacity , effect of pH on nutrient availability
22. Soil colloids - Definition - General properties - Shape, surface area, electrical charge, adsorption, flocculation, deflocculation, plasticity, cohesion, swelling, shrinkage, Tyndall effect and Brownian movement
23. Secondary silicate clay minerals - Classification based on structure - Properties of kaolinite, illite, montmorillonite and chlorite - Properties - Allophones.
24. Origin of charge in organic and inorganic colloids - Negative and positive charges - Differences between organic and inorganic soil colloids
25. Adsorption of ions - Types of ion exchange - Cation and anion exchange - Cation and anion exchange capacities of soil - Base saturation - Factors affecting ion exchange

capacity of soils - importance of Cation Exchange Capacity (CEC) of soils - Calculation of base exchange capacity and exchangeable acidity

26. Soil biology - Biomass - Flora and fauna - Their important characteristics - Role of beneficial organisms - Organic matter decomposition, mineralization and immobilization
27. Nitrogen fixation, denitrification, solubilization of phosphorus and biological control of plant diseases - Promotion of plant growth promoting substances - Harmful activities of soil organisms
28. Soil organic matter - Various sources - Composition - Compounds in plant residues - Their decomposability - Humus - Definition - Synthesis of humus
29. Importance of soil organic matter and humus – Fractionation of soil humus – Carbon cycle - Carbon: nitrogen (C:N) ratio of commonly available organic residues - Significance of C:N ratio in soil fertility
30. Soil classification - Early system of soil classification - Diagnostic horizons- Surface and sub-surface horizons```
31. Soil taxonomy - Keys to soil orders - Criteria at each category of Order suborder, great group, subgroup, family and series - Nomenclature according to soil taxonomy
32. Soils of India - Major characteristics - Potentials and limitations - Alluvial soils, black soils, red soils, laterite soils salt affected, desert soils, Forest and hilly soils and peat and marshy soils.

Practicals

1. Study of general properties of minerals - Silicate and non - Silicate
2. Study of igneous, sedentary and metamorphic rocks
3. Study of soil sampling tools, collection of representative soil sample, its processing and storage
4. Description of soil profile in the field
5. Determination of texture by feel method
6. Determination of mechanical composition of soil using Bouyoucos Hydrometer
7. Determination of bulk density of soil
8. Determination of particle density of soil and porosity
9. Determination of soil moisture content by gravimetric method
10. Determination of infiltration rate of soil
11. Determination of soil moisture constants- Field capacity
12. Determination of pH and EC of soil
13. Aggregate analysis by wet sieving method
14. Determination of water holding capacity of soil
15. Determination of cation exchange capacity of soil
16. Determination of soil colour

Suggested Readings

1. Soil Fertility and Nutrient Management. S S Singh, Kalyani Publishers.
2. Introductory Soil Science D. K .Das. Kalyani publishers, New Delhi
3. Soil Fertility and Fertilizers Samuel Tisdale, Nelson Werner L, Beaton James D and Havlin John L.: Macmillian Publishing Co., New York.
4. The Nature and properties of soils - Harry, O Buckman and Nyle C
5. A text book of Pedology - concepts and applications- Sehagal,J.Kalyani publishers,New Delhi.

SSAC 122
SOIL FERTILITY MANAGEMENT
3 (2+1)

Objective

1. To provide comprehensive knowledge of soil fertility, plant nutrition, fertilizersand nutrient management

Course Outlines

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 micro-nutrients. 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 applictions of Colorimetry and flame photometry; Estimation of alkaline hydrolysable N in soils; Estimation of soil extractable P in soils; Estimation of exchangeable K in soils; Estimaion 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.

Lecture Outlines

Theory

1. History of soil fertility and plant nutrition - Concepts of soil fertility, soil productivity, Soil as a source of plant nutrients - Different forms of Nutrient Elements in soil - Arnon's criteria of essentiality - list of essential, functional and beneficial elements
2. Essential nutrients - Classification and their functions in plants- Deficiency symptoms of nutrients - Corrective measures (Nitrogen, phosphorus, potassium, calcium, magnesium, Sulphur, Iron, Copper, Zinc, Manganese, Boron, Molybdenum and Chloride)
3. Toxicity symptoms of nutrients - Mechanism of nutrient transport - Movement of ions from soils to roots - Mass flow, diffusion, root interception and contact exchange. Factors effecting nutrient availability to plants- Chemistry of Macro and Micro nutrients
4. Nitrogen - Occurrence, content and distribution. Factors influencing the content of nitrogen in soil. Forms of soil nitrogen. Nitrogen Cycle - Transformations in soils - Mineralization (aminisation and ammonification) - Fate of released ammonia -

Factors affecting ammonium fixation. Nitrification - Factors affecting nitrification - Fate of released nitrate nitrogen - Toxicity symptoms of nitrogen

5. Leaching losses of nitrate nitrogen - Nitrification inhibitors-Denitrification - Immobilization, Nitrogen fixation - Different types - Biological fixation of nitrogen - Symbiotic and non symbiotic - Nitrogen balance sheet - Gains and losses
6. Phosphorus - P-Cycle - Content in soils - Forms of phosphorus in soil - Inorganic and organic phosphorus compounds - Phosphorus fixation - Mechanisms of phosphate fixation - Factors affecting phosphate fixation in soil - Quantity and intensity parameters
7. Potassium - content in soil - Source - forms of soil potassium - Potassium fixation. Factors affecting potassium fixation - Quantity and Intensity parameters - Luxury consumption
8. Calcium - Sources and content - Forms of calcium in soil, factors affecting the availability of calcium in soil - Magnesium - Sources - Content - Forms of magnesium in soils - Factors affecting availability of magnesium functions
9. Sulphur - S-Cycle - Occurrence - Forms of Sulphur in soil - Sulphur transformation in soils - Mineralization and immobilization. Sulphur Oxidation - Factors affecting oxidation in soils - Sulphide injury - Causes, symptoms and remedial measures
10. Zn, Mn - Content - Forms in soils - Critical limits in soils and plants - Factors affecting availability
11. Fe and Cu - Content - Forms in soils - Critical limits in soils and plants - Factors affecting availability
12. Boron and Molybdenum - Content - Forms in soil - Critical limits in soils and plants - Factors affecting their availability
13. Chloride - Content - Forms in soils - Critical limits in soils and plants - Factors affecting its availability - Important functions and properties of beneficial (Sodium, cobalt , vanadium and Silicon) elements and Nickel
14. Soil fertility Evaluation - Approaches - Soil testing - Objectives of soil testing - Chemical methods for estimating available nutrients - Critical levels of different nutrients in soil
15. Plant analysis - Rapid tissue tests - Indicator plants - Biological methods of soil fertility evaluation, A- value
16. Microbiological methods - Sackett and Stewart techniques - Mehlich technique - Cunninghamella plaque method - Mulder's Aspergillusniger technique - Mistcherlich's pot culture method
17. Integrated Nutrient Management (INM)- Objectives - Components – Advantages
18. Importance of organic manures - Definition and difference between manures and fertilizers- Classification of manures (Bulky & Concentrated) with suitable examples - Importance of manures in soil fertility management
19. Bulky organic manures - Preparation of FYM – Methods of collection and storage - Losses of nutrients from FYM during collection and storage -Ways to minimize these losses
20. Compost and composting - Different methods of composting including the starters and raw materials
21. Methods of preparation of rural and urban compost - Mechanical compost plants - Their advantages over conventional composting - Vermi-composting
22. Green manures - Classification with examples - Advantages and limitations of green

manuring and green leaf manuring. Biogas plant - Principles of operation and its advantages

23. Definitions of penning, sewage, sewerage, sullage, Pouderette, Activated compost process. Concentrated organic manures - Oil cakes, blood meal, bone meal, horn meal, fish meal, meat meal and Guano
24. Carbon sequestration, types of carbon sequestration and carbon trading, carbon credits and carbon markets
25. Chemical fertilizers - Classification with examples - Composition and properties of major nitrogenous fertilizers viz., Ammonium sulphate, urea and calcium ammonium nitrate
26. Phosphatic fertilizers - Composition of Rock phosphate – Occurrence, types and properties - Properties of SSP, TSP and basic slag - Potassic fertilizers - MOP, SOP properties
27. Secondary nutrient fertilizers- Micronutrient fertilizers- Complex fertilizers - Types, composition of DAP, MAP, UAP, important nitrophosphates
28. Nano-fertilizers - Water soluble fertilizers- Customized fertilizers, Mixed fertilizers - Advantages and disadvantages over straight fertilizers. Fertilizer grade - Fertilizer ratio - Unit value of fertilizers - Problems
29. Soil amendments - Role of important organic and inorganic amendments and synthetic conditioners as amendments
30. Fertilizer storage - Specifications - Problems during storage - Fertilizer Control Order (FCO) - Its importance and regulations - Specifications for important fertilizers
31. Methods of fertilizer applications to crops - Nutrient use efficiency - Soil, plant and management factors influencing Nutrient use efficiency in respect of N, P, K, S, Fe and Zn fertilizers
32. Fertilizers recommendations to crops - Soil test based fertilizers recommendation (STCR) and RTNM and IPNS

Practicals

1. Introduction to analytical instruments, principles and calibration
2. Estimation of soil organic carbon content by Walkley & black method
3. Estimation of alkaline hydrolysable N in soils
4. Estimation of extractable P in soils using colorimetry
5. Estimation of available K in soils using flame photometry
6. Estimation of available Ca and Mg in soils
7. Estimation of available S in soils
8. Estimation of DTPA extractable Zn in soils using atomic absorption spectroscopy
9. Basics of Plant analysis and Estimation of N in plant sample
10. Estimation of P in plant samples
11. Estimation of K & S in plant samples
12. Estimation of Nitrogen in organic manures
13. Identification of acid radicals in fertilizers
14. Identification of basic radicals in fertilizers
15. Estimation of Nitrogen in Urea ammonium sulphate
16. Eestimation of potassium in MOP by flame photometer method

Suggested Readings

1. Soil Fertility and Nutrient Management. S S Singh, Kalyani Publishers.
2. Introductory Soil Science D. K .Das. Kalyani publishers, New Delhi

3. Soil Fertility and Fertilizers, Samuel Tisdale, Nelson Werner L, Beaton James D and Havlin JohnL.: Macmillian Publishing Co., New York.
4. The Nature and properties of soils – Harry, O Buckman and Nyle C
5. Comprehensive and competitive soil science - P.Gurumurthy, M.V.S.Naidu, T.V.Sridhar, K,.Himabindu and V.Surya Teja, Narendra Publishing house

SSAC 221
PROBLEMATIC SOILS AND THEIR MANAGEMENT
2 (1+1)

Objective

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

Course Outlines

Theory

Soil quality and health, Distribution of Waste land and problem soils in India with special reference to Assam and North Eastern Region. 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. Management of Riverine soils, Water logged soils, Contaminated soils (Pesticide contamination, Heavy metal contamination), Mined soils (Coal mined, Oil mined), 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 classification, land suitability classification.

Practical

Determination of pH 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^{-2},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.

Lecture Outlines

Theory

1. Soil quality and Health- Definition - Concepts - Soil resilience - Factors affecting soil quality (Physical, chemical and biological) - Assessment of soil quality - Management and improvement of soil quality.
2. Problem soils - Definition - Different types of problematic soils - Extent and distribution of problematic and waste lands soils in different agro-eco systems in Andhra Pradesh. Categorization of problematic soils based on physical, chemical and biological properties.
3. Salt affected soils - Origin and formation - Distribution of salt affected soils in India

and Andhra Pradesh. Characteristic features of saline, sodic and saline - Sodic soils - Diagnostic criteria based on properties

4. Saline soils - Visual symptoms for identification of saline soils - Build up of salinity - Effect of salinity on plant growth and nutrient availability - Reclamation and management.
5. Sodic soils - Visual symptoms for identification of sodic soils - Effect of sodicity on plant growth and nutrient availability - Reclamation and management.
6. Saline - sodic soils - Visual symptoms for identification of saline - Sodic soils – Effect of salinity on plant growth and nutrient availability - Reclamation and management.
7. Acid soils - Extent of area in India and Andhra Pradesh - Formation - Characteristics of acid soils - Sources of soil acidity - Nutrient limitations and toxicity - Reclamation of acid soils - Different liming materials used for reclamation - Benefits of liming - Harmful effects of over liming.
8. Acid sulphate soils - Origin - Types - Characterization-Constraints and management.
9. Land degradation - Eroded, compacted, flooded and water logged soils - Biologically sick soils - Effects on plant growth - Management.
10. Polluted soils - Definition - Sources of pollution - Bio solid wastes - Industrial effluents (distillery, paper mill, tannery, textiles industrial effluents) - Mechanism of interaction of wastes with soil.
11. Soil pollution - Potentially toxic elements - Excessive use of fertilizers, pesticides and weedicides - Heavy metal contamination - Management.
12. Mined soils (Coal mined & Oil mined) - Riverine soils- Water logged soil - Formation- Properties and their management
13. Irrigation water - Quality and standard parameters - Classification based on ICAR, CSSRI and USDA criteria - Guidelines for judging quality of water - Utilization of saline water in agriculture.
14. Remote Sensing and GIS techniques in diagnosis, mapping and management of degraded and problematic soils.
15. Bio-remediation of problem soils through Multi Purpose Tree Species (MPT'S)
16. Land suitability classification - Land Capability Classification

Practicals

1. Field identification of problematic soils and visit to degrade lands.
2. Determination of pH and EC of salt affected soils (acid, saline and alkali) in saturated extract paste
3. Determination of redox potential in soil
4. Estimation of water soluble and exchangeable cations and computation of SAR and RSC in soil
5. Determination of pH and EC of saline, sodic and good quality irrigation water.
6. Determination of CO_3^{-2} and HCO_3^{-} in irrigation water.
7. Determination of chlorides in irrigation water.
8. Determination of Ca and Mg content in irrigation water.
9. Determination of Na and K content in irrigation water.
10. Computation of quality class, RSC and SAR of irrigation water.
11. Determination of Gypsum requirement (GR) of sodic soils
12. Determination of Lime Requirement of acid soils
13. Determination of ESP of sodic soils.

14. Determination of aggregate stability of sodic soils
15. Determination of nitrates in irrigation water
16. Determination of dissolved oxygen and free carbondioxide levels in water samples

Suggested Readings

1. Saline alkali soils of India- Agarwal R R, Yadav .J S P and Gupta R N - ICAR AGRBIOS (India)
2. Nature and properties of soils- Brady Nyle C and Ray R Well- Pearson education INC. New Delhi
3. Principle of Remote sensing - Cirsan J. Paul., - Longman New Yark ,
4. Indian Society of Soil Science. Fundamentals of Soil Science, IARI, New Delhi.
5. Management of soil problems- Osman, Khan Towhid – Springer publication
6. Management of problem soils- Principles and practices- Srivastava V C - New Delhi

SEC V

SOIL, PLANT AND WATER TESTING

2 (0+2)

Practicals

1. Introduction to Analytical instruments- Calorimetry, Flame photometry and atomic absorption spectrophotometer.
2. Standardization of solutions and reagents and acid base titrations
3. Collection and preparation of soil samples
4. Determination of soil moisture content by gravimetric method
5. Determination of bulk density in soil samples
6. Determination of particle density and porosity
7. Determination of aggregate stability by Yoder's apparatus
8. Estimation of soil pH and EC
9. Estimation of soil organic carbon- Qualitative and quantitative
10. Estimation of available soil nitrogen by Subbiah and Asija method
11. Estimation of available soil phosphorus by Olsen's method and Brays & Kurtz method
12. Estimation of available soil potassium by flame photometer method
13. Estimation of soil sulphur by turbidity method
14. Estimation of Ca and Mg in soils
15. Estimation of DTPA extractable soil micronutrients by AAS
16. Estimation of CEC and exchangeable sodium in soil
17. Estimation of Gypsum requirement
18. Estimation of Lime requirement
19. Estimation of calcium carbonate in soil
20. Plant sampling and sample preparation and digestion for analysis
21. Estimation of N in plant sample
22. Estimation of P in plant sample
23. Estimation of K in plant sample
24. Estimation of S in plant sample
25. Rapid plant tissue test for N, P and K
26. Collection of irrigation water sample and quality assessment parameters
27. Determination of EC and pH of irrigation water

28. Estimation of Ca and Mg in Irrigation water
29. Estimation of carbonates and bicarbonates in Irrigation water
30. Estimation of chlorides and sulphates in Irrigation water
31. Estimation of sodium and potassium in irrigation water
32. Computation of SAR and RSC

Suggested Readings

1. Methods of analysis of soils, plants waters, fertilizers and organic manures - H L S Tandon- Fertilizer development and consultation organisation, New Delhi, India.
2. A Text book of soil chemical analysis- P R Hesse - Sathish Kumar Jain for CBS publishers and distributors, New Delhi
3. Soil, plant water and fertilser analysis- P K Gupta

ELCT 421
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

Course Outlines

Theory

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Inter relationships 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 land slides, soil erosion and desertification. Landscape impact analysis, wetland ecology & 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. Levelling 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.

Lecture Outlines

Theory

1. SSAC - Natural resource bases – Introduction - Concept of resource - Classification of natural resources - Carrying capacity and ecological food print and sustainability - Sustainable portfolios and sustainable development goals
2. SSAC - Natural resources of India – Renewable and non- Renewable resources, land, forest, water, power and mineral resources, distribution and uses - Natural resources and associated problems
3. SSAC - Factors influencing resource availability - Interrelationships among different types of natural resources - Concern on Productivity issues
4. SSAC - Resource management of sustainable development – Ecological dimension, social dimensions, economic dimension and integration of all dimensions

5&6. SSAC - Land resources - Land as a resource - Dry land, Agricultural land, forest land, wet lands, urban lands, desert lands-Land Use Categories - Land-use Changes in India-Land use classification (nine fold classification i.e Forests - Land put to non-agricultural uses, Barren and unculturable land, Permanent pastures and other grazing lands - Miscellaneous tree crops and groves, not included in the net area sown, Culturable waste, Fallow land, other than current fallows - Current fallows and Net area sown)

7. SSAC - Land resource management - Importance, Techniques and Applications key components - Challenges Strategies
8. SSAC - Land degradation – Man induced landslides, soil erosion and desertification - Types, factors and causes of land degradation
9. SSAC - Land degradation - GLASOD classification application of GIS and remote sensing in monitoring, diagnosis and mapping land degradation
10. SSAC - Soil erosion problems in India- History, distribution identification and description of soil erosion problems in India
11. SSAC - Soil erosion - Forms of soil erosion - Impact of soil erosion-on-site and off-site effects - Strategies for erosion control and conservation of soil
12. SSAC - Water erosion - Types of water erosion, forms and classification of watererosion
13. SSAC - Gullies and their classification stages of gully development and control measures
14. AENG - Soil loss estimation - Universal soil loss equation- Rainfall Erosivity factor (R)-Soil erodibility factor(K)- Topographic factor (LS)-Crop Management factor(C) - Support practice factor (P).
15. AENG - Measurement of soil erosion - Runoff plots, soil samplers - Multi slot devisor and Coshocton wheel sampler
16. AENG - Rainfall Erosivity, methods of measurement and prediction of runoff losses
17. AENG - Uses of USLE- Limitations of Universal soil loss equation- Revised Uni

versal soil loss Equation (RUSLE)-Modified Universal soil loss equation (MU SLE)

18. SSAC - Causes and agents of soil erosion - factors affecting soil erosion
19. SSAC - Soil conservation in hilly, arid, semiarid, coastal and diary lands- Im pacts and activities to be taken up in soil conservation
20. SSAC - Management of forest, peat and muck soils - Impacts and activities to be taken up in soil conservation
21. SSAC - Landscape impact analysis, Landscape Character Assessment Criteria - Landscape quality.
22. SSAC - Wetland ecology and management, Types of wetlands - Hydrological conditions Biological functions- Site-specific conditions
23. SSAC Water resources: Use and over-utilization of surface and ground water, Natural disasters- Floods, drought - Conflicts over water - Dams-benefits and problems
24. SSAC - Water ecology and management - Water quality management- Water Quality Objectives and Standards- Physical Parameters- River water quality model and lake water quality model
25. SSAC - Energy resources - Growing energy needs - Renewable and nonrenew able energy sources - Use of alternate energy sources - Benefits of alternative energy sources - Growing energy needs - Global variations in energy use - Indi an Scenario
26. SSAC - Field residues- Uses of Agro-Residues as Biomass (second generation biofuel) Energy- Benefits of using agro-residue as a source of energy
27. SSAC - Nuclear energy - Different methods of nuclear energy - Applications of Nuclear Energy- Advantages of Nuclear Energy - Disadvantages of Nuclear En ergy
28. AENG - Wind erosion- Forms of wind erosion- Factors affecting wind erosion - Wind erosion equation - Management practices
29. AENG - Wind erosion - Mechanics of wind erosion, types of soil movement - Principles of wind erosion control and its control measures
30. AENG - Principles of wind erosion control and its control measures– Vegeta tive and mechanical measures
31. SSAC - Soil conservation planning - Land capability classification - Classes, sub classes and units.
32. SSAC - Soil conservation in special problem areas - Hilly, arid and semi-arid regions, Soil conservation in special problem areas - Water logged and wetlands
33&34. SSAC - Resource Management Paradigms: Resource management the evolu tion and history of resource management paradigms- India's resource management problems, review paradigm concept - Analyze evolution and application of identified paradigms and sub-paradigms and compare global and Indian experiences.
35. SSAC - Resource conflicts - Resource extraction, access and control system - The Role of Natural Resources and the Environment in Fueling Conflict - The Conflicts - Efforts for Resolutions - Factors Leading to Resource Conflict , Resolving Resource Conflicts
36. SSAC - Approaches in Resource Management - Ecological approach; economic approach, Behavioral Approach, Integrated Approach, Institutional Approach,

Community Based Approach and Technological Approach

37. SSAC - Ethnological approach - Implications of the approaches - Integrated resource management strategies
38. SSAC - Land restoration and conservation techniques - Erosion control
39. SSAC - Reclamation of salt affected soils - Saline soils- Alkali/ sodic soils - saline sodic or Saline – alkali soils- Management practices
40. SSAC - Reclamation of saline soils in detail - Their characteristic features - Management practices of saline soils
41. SSAC - Reclamation of alkali /Sodic soils and their management practices
42. SSAC - Reclamation of saline- sodic or Saline- alkali soils and their management
43. SSAC - Mine land reclamation - Afforestation, organic products - Soil fauna and biodegradation, Mechanical methods and agronomic of erosion control
44. SSAC - Soil and water conservation, Research Centers in India and soil conser vation problems in India
45. AENG - Land Use classification, principles of erosion control - Introduction to contouring, strip cropping
46. AENG - Classification of bunding system, Contour bund, graded bund and types of bench terracing
47. AENG - Water harvesting – Principles, advantages and disadvantages of water harvesting, importance and issues
48. AENG - Water harvesting techniques - Lining of ponds, tanks and canal systems

Practicals

1. AENG - Identifying natural resources and their utility.
2. AENG - Acquaintance with the survey instruments, Folding, unfolding of the chain and pacing technique for measurement.
3. AENG - Area calculations through chain survey.
4. AENG - GPS demo for tracking and area measurement.
5. AENG - Levelling concepts and practical utility in agriculture.
6. AENG - Methods of contour, Direct method for locating contour, Location of contours by direct method using radial lines Indirect method for locating contours – Grid method.
7. AENG - Drawing of contour map (Grid method).
8. AENG - Estimation of soil loss by Universal Soil Loss Equation and calculation of erosion index.
9. AENG - Concept of vegetative water ways and design of grassed water ways.
10. AENG - Wind erosion and estimation process.
11. AENG - Different irrigation pumps and their constructional differences.
12. AENG - Farm pond construction and its design aspects.
13. AENG - Visit to nearby farm pond.
14. AENG - Visit to an erosion site.
15. AENG - Exposure to strip cropping/contour bunding
16. AENG - Final Practical Exam

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 Black swan 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.

ELCT 423
BIOPESTICIDES AND BIOFERTILIZERS
4 (3+1)

Objectives

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

Course Outlines

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, andbio rationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes, Methods of applicationof bio pesticides. Methods of quality control and Techniques of bio pesticides. Impediments andlimitation in production and use of bio pesticides.

Biofertilizers - Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers - Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cynobacterial bio fertilizers-Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers, AM mycorrhiza and ectomycorhiza. Nitrogen fixation - Free living and symbiotic nitrogen fixation.Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. Production Technology: Strain selection, sterilization, growth and fermentation, mass production of carrierbased 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 biopestisides: Trichoderma, Pseudomonas, Bacillus, Metarhyziumetc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides. Isolation and purification of Azospirillum, Azotobactor, Rhizobium, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi- Wet sievingmethod and sucrose gradient method. Mass production of AM inoculants.

Lecture Outlines

Theory

1. PATH - History and concept of biopesticides; Definitions, concepts and classification of biopesticides(Pathogens, Botanicals & Biorationals).
2. PATH - Biopesticides - Pathogens : Entomopathogenic bacteria- Classification - Spore forming - Crystalliferous and Non crystalliferous; Non spore forming,
3. PATH - Biopesticides - Pathogens : Virulence, Pathogenicity and Symptoms.
4. PATH - Biopesticides - Pathogens : Mass Production and Application methods.
5. PATH - Biopesticides - Pathogens : Quality control & limitations.
6. PATH - Biopesticides - Pathogens - Entomopathogenic viruses; Classification - Polyhedral Inclusion Bodies (Nucleo and Cytoplasmic); Granulovirus and Non inclusion virus.
7. PATH - Biopesticides - Pathogens - Entomopathogenic viruses; Virulence, Pathogenicity and Symptoms.
8. PATH - Biopesticides - Pathogens - Entomopathogenic viruses; Mass Production and Application methods.
9. PATH - Biopesticides - Pathogens - Entomopathogenic viruses; Quality control & limitations.
10. PATH - Biopesticides - Pathogens - Entomopathogenic fungi; Classification (fungi belonging to phyla, Zygomycota, Ascomycota and Deuteromycota).
11. PATH - Biopesticides - Pathogens - Entomopathogenic fungi; Virulence, Pathogenicity and Symptoms.
12. PATH - Biopesticides - Pathogens - Entomopathogenic fungi; Mass Production and Application methods.
13. PATH - Biopesticides - Pathogens - Entomopathogenic fungi; Quality control & limitations.
14. PATH - Biopesticides - (Protozoa and EPN); Entomopathogenic Protozoa, Entomopathogenic Nematodes (Steinernematidae, Heterorhabditidae).
15. PATH - Biopesticides - (Protozoa and EPN); Virulence, Pathogenicity and Symptoms.
16. PATH - Biopesticides - (Protozoa and EPN); Mass Production and Application methods.
17. PATH - Biopesticides - (Protozoa and EPN); Quality control & limitations.
18. ENTO - Biopesticides; Botanical pesticides - Plants having insecticidal properties viz., Neem, Chrysanthemum, Pongamia, Custard apple, Derris, Tobacco, Ryania, Sabadilla andSweetflag.
19. ENTO - Botanical pesticides - Active ingredients, mode of action, Uses, Advantages and limitations.
20. ENTO - Biorationals; Insecticides from animal and other microbial origin.
21. ENTO - Biorationals; Potential-Safety to non-target organisms – Pheromones, Chitin synthesis inhibitors, Juvenile Hormones.
22. ENTO -Biorationals; Moulting Hormones and Male sterile technique.
23. PATH - Trichoderma and Fluorescent pseudomonads; Species, mode of action, Mass Production.
24. PATH - Trichoderma and Fluorescent pseudomonads; Application methods, Quality control.
25. SSAC - Introduction Structure and characteristics features of Biofertilizers; Biofer-

tilizers production and application scenario in world and India
26. SSAC - Importance of biofertilizers
27. SSAC - Biofertilizers influence on soil health
28. SSAC - Types of biofertilizers based on nutrient supply.
29. SSAC - Nitrogen fixers; Symbiotic, Associative and freeliving nitrogen fixers - Mechanisms of biological nitrogen fixation.
30. SSAC - Nitrogen fixers; -Symbiotic nitrogen fixers:Rhizobium, Anabaena and Frankia, Rhizobium -Types of Rhizobium and rhizobial cross inoculation groups.
31. SSAC - Nitrogen fixers; Nodulation process in legumes by Rhizobium and factors influencing nodulation.
32. SSAC - Isolation, purification and maintenance of Rhizobium
33. SSAC - Screening to select efficient Rhizobium w.r.t. N2fixation by acetylene reduction assay (ARA)
34. SSAC - Free living nitrogen fixers; Azotobacter: Important characteristic features - Isolation, purification and maintenance-Screening to select efficient Azotobacter w.r.t. N2fixation by acetylene reduction assay (ARA).
35. SSAC - Azospirillum: Important characteristic features-Isolation, purification and maintenance. Screening to select efficient Azospirillumw.r.t. N2 fixation by acetylene reduction assay (ARA).
36. SSAC - Free living nitrogen fixers; Blue green algae (BGA): Important characteristic features-Isolation, purification and maintenance-Types of BGA-Tolypothrix, Ocillotoria, apalosiphon, Nostocetc- Screening to select efficient BGA w.r.t. N2fixation by acetylene reduction assay (ARA).
37. SSAC - Associative nitrogen fixers; Acetobacter diazotrophicus: Important characteristic features- Isolation, purification and maintenance.
38. SSAC - Screening to select efficient Acetobacter diazotrophicusw.r.t. N2fixation by acetylene reduction assay (ARA).
39. SSAC - Microbial mineral phosphate solubilization; Phosphate solubilizing bacteria (PSB) and Fungi (PSM):Bacteria and fungi involved, characteristic features, Mechanisms--Isolation, purification and maintenance -Screening to select efficient PSB by spot inoculation on Alexandro's agar and broth.
40. SSAC - Microbial Potash solubilization; Potash solubilizing bacteria (KSB):Bacteria involved, characteristics features, Mechanisms--Isolation, purification and maintenance -Screening to select efficient KSB by spot inoculation on Pikovoskya's agar and broth.
41. SSAC - Zinc Solubilizing bacteria (ZSB); Bacteria involved, characteristics features, Mechanisms- Isolation, purification and maintenance-Screening to select efficient ZSB by spot inoculation on Bunt and Rovira's agar and broth.
42. SSAC - Silica Solubilizing bacteria(ZSB); Bacteria involved, characteristics features, Mechanisms- Isolation, purification and maintenance-Screening to select efficient SSB by spot inoculation on Bunt and Rovira's agar and broth.
43. SSAC - Sulfur oxidizing bacteria(SOB); Bacteria involved, characteristics features, Mechanisms - Isolation, purification and maintenance--Screening to select efficient SOB by spotinoculation on Bunt and Rovira's agar and broth.
44. SSAC - Phosphate mobilizers; Mycorrhizae:Types of mycorrhiza: Ecto and Endomycorrhiza - Importance of mycorrhiza-Endomycorrhiza-Arbuscular Mycorrhiza, Arbutoid mycorrhiza, Ericoid mycorrhiza, Orchid mycorrhiza.

45. SSAC - Phosphate mobilizers; Mycorrhizae: Ectomycorrhiza-Amanita, Boletus, Puffballs Arbuscular mycorrhizal fungi-Different genera, Isolation, characterization, pure culture development and mass multiplication.
46. SSAC - Plant growth promoting rhizobacteria (PGPR); Importance of PGPRs in agriculture. Different PGPR bacteria: Bacillus, Pseudomonas, Penibacillus, Pantoea etc-Impotance, their isolation, purification, maintenance, mass multiplication and field application.
47. SSAC - Biofertilizers production; Isolation/Culture collection, Maintenance, Preparation of starter culture, Mass multiplication.
48. SSAC - Preparation of Biofertilizers formulations (Liquid and Powder)- Packing bottling, Quality control (BIS and FCO specifications), Storage, distribution and field application, Dosage, methods of application, precautions while applying biofertilizers to enhance the efficiency of biofertilizers in field.

Practicals

1. ENTO - Identification of important botanicals
2. ENTO - Aqueous Extraction and preparation of crude extracts viz., NSKE (Neem Seed Kernal Extraction), Tobacco decoction, Leaf Extracts of Pongamia, Custard apple etc.
3. ENTO - Field exploration, Identification & isolation of different entomopathogens from the infected cadavers; Visit to nearby biopesticide laboratory.
4. ENTO - Study on preparation or mass production technology of important biopesticides like Entomopathogenic bacteria on suitable laboratory reared insect host cultures.
5. ENTO - Study on preparation or mass production technology of important biopesticides like *Metarhiziumanisopliae* on suitable laboratory reared insect host cultures.
6. PATH - Study on preparation or mass production technology of important biopesticides like Entomopathogenic viruses-SlNPV or HaNPV
7. SSAC - Introduction to equipment, glass ware and other requirements for isolation, purification and maintenance of biofertilizers.
8. SSAC - Introduction to equipment, glass ware and other requirements for mass production of biofertilizers.
9. SSAC - Isolation, purification and maintenance of Rhizobium
10. SSAC - Isolation, purification and maintenance of Azospirillum
11. SSAC - Isolation, purification and maintenance of Azotobacter
12. SSAC - Isolation, purification and maintenance of Phosphate solubilizers and Potash Solubilizers
13. SSAC - Isolation, purification and maintenance of Zinc and silica solubilizers, and Sulfur oxidizers
14. SSAC - Isolation, purification and maintenance of AM fungi and mass multiplication of AM fungi by plant host based pot culture technique
15. SSAC - Mass multiplication of biofertilizersandpreparation of differentformulations of biofertilizers
16. SSAC - Quality control aspects of biofertilizers and demonstration of different methods of application of biofertilizers

References for Practicals

1. Himadri Panda, A complete Technology Book biofertilizers and organic farming, 3rdEdition, NIIR Project Consultancy Services, New Delhi.

2. Hand Book of Microbial Biofertilizers by M.K.Rai, NBHS Academic and Professional Books, New Delhi.
3. Biofertilizers Manual, Forum for Nuclear Cooperation in Asia (FNCA),Japan Atomic Industrial Forum, Japan.
4. JjaynathYadhav, A., Production Technology for Bioagents and Biofertilizers-A Practical Manual, Baru Sahib, Sirmour-173101, Himachal Pradesh, India.

Suggested Readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American
2. Phytopathological Society.
3. Boand, 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
6. Management. Edited Pujblished by Springer.
7. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural Products.
8. Gnanamanickam, S.S. 2002. Biological control of crop Disease. Kuykendall Marel Dekker, INC.
9. Ignacimuthu SJ and S. Jayaraj. Green Pesticides for Insect Pest Management. 21 July 2005. ISBN- 13: 978-8173196867 ISBN-10: 8173196869.
10. Jan Dirk van Elsas, Jack T. Trevors, Alexandre Soares Rosado, Paolo Nannipieri, Modern Soil Microbiology, Third Edition, CRC Press, Boca Raton, Florida, USA.2019.
11. Parmar and BS &Deva Kumar C.1993 Botanical and Bio pesticides. West Will Publishing House, New Delhi pp 199.
12. Ramanathan, N., Biofertilizers Technology, 1st Edition, Kalyani Publications, Kolkata, India,2019.
13. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic organisms in India. Precision Fototype Services Bangalore.
14. Rangaswamy and Bagyaraj, D.J., Edition, 2. Prentice-Hall of India, New Delhi,2007.
15. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services Services Bangalore.
16. Subba RaoN.S., Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Co., India,1977.

ELCT 424
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. To provide a comprehensive knowledge of remore sensing, precision farming and its benefits in improving crop production and soil health management

Course Outlines

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.

What is artificial intelligence; History of artificial intelligence, Fundamentals of big data & machine learning (ML), Use of artificial intelligence in autonomous systems: agricultural robots and drone monitoring systems, driverless tractors, automated sprinklers and self-harvesting machines etc.;

Use of AI in crop analysis:monitoring soil quality, promoting organic crops, monitoring weeds, precision agriculture, using drones for crop analysis; Role of AI for sustainability and climate change, yield and demand forecasting, food tech/wider value chain including impact of block chain, AI use for in the emerging markets; Technology deployment likesensors , AI and agricultural technologies and How to scale AI for agricultural technologies applications, Responsible AI in agriculture, 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.

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. Live examples and case study of AI use in Agriculture, Search and Control strategies: Blind search, Breadth -first search, Depth First search, Hill climbing method, Best First search, Branch and Bound search, Programming in Prolog Syntax and meaning of Prolog Programs. Using Data Structures. Controlling Back tracking. Input and Output. Built-in Predicates, Using Prolog Grammar Rules. Higher level assignments/ exercises for implementation using Prolog.

Lecture Outlines

Theory

1. AGRO - Over view of Precision Farming- Concepts and Principles, Historical developments - Components of Precision Farming – RS-GPS/GIS/Ariel
2. AGRO - Global Trends in Precision Farming- Government initiatives for precision farming- Central and state- Advantages and limitations of Precision farming in Indian Context
3. AGRO - Geoinformatics-Definition- Concepts and techniques (Remote Sensing, GIS and GPS) and their use in Precision farming.
4. AGRO - Global positioning system-Components- Advances and its applications
5. SSAC - Data Sources - Remote Sensing - Satellite, Aerial, and UAV Sources - Introduction to Remote sensing - Definition - Historical developments - Remote sensing platforms
6. SSAC - Types of remote sensing- Remote Sensing Institutes in India- Overview of key institutions: NRSC (National Remote Sensing Centre), IIRS (Indian Institute of Remote Sensing), ISRO
7. SSAC - Principles of Remote Sensing- Components of Remote sensing- Electromag-

netic spectrum, energy interactions with atmosphere and Earth's surface, spectral reflectance of various earth surface features and Atmospheric windows.

8. SSAC - Radiation propagation in the Atmosphere- Scattering, absorption, and reflection of EM radiation
9. SSAC - Interaction of radiation with matter-reflection, transmission, and absorption of radiation by soil, vegetation, water, Remote sensing sensors
10. SSAC - Spectral signatures and Concept of resolution - Spatial, spectral, temporal, radiometric
11. SSAC - Hyperspectral Remote Sensing - Thermal Remote Sensing- Thermal Imaging for Precision Agriculture
12. SSAC- Arial photographs - Types and characteristics - Interpretation of Arial photographs,
13. AGRO - Unmanned Ariel vehicle (UAVs) -Introduction -Components types- Advantages and limitations - Sensors-uses
14. SSAC - Advantages of Remote Sensing - Large-scale data acquisition, time efficiency, repeatability, non-invasive data collection - Disadvantages of Remote Sensing-High cost, complex data analysis, spatial and temporal resolution limitations
15. SSAC - Pre-processing of satellite images- Geometric correction, Atmospheric correction and Radiometric correction.
16. SSAC - Processing of satellite images - Image enhancement, feature extraction - Segmentation, fusion
17. AGRO - Geodesy and its basic principles- Laser levelling for precision farming- Spatial data and their management in GIS
18. AGRO - Spatial data management- Data Analysis Techniques for Precision Agriculture-Data Mining, Predictive Analytics, and Integration with Precision Farming Software, GIS-Introduction to GIS in Agriculture, Spatial data management and analysis, Mapping techniques for precision agriculture
19. AGRO - Variable rate technology (VRT) - Components of VRT- Sensors, GPS/Geospatial Data, Software, Machinery.
20. AGRO - Crop discrimination and Yield monitoring techniques
21. AGRO - Crop modelling - Types - Advantages and limitations
22. SSAC - Interpretation of remote sensing data- Classification, change detection, Basics of Machine Learning: Random forest, SVM, ensemble methods; Basics of Deep learning, Data Sharing in Precision Agriculture - Open data platforms, cloud computing, interoperability, geospatial standards
23. SSAC - Introduction to Expert Systems- Definition of expert systems, key components, rule-based systems- Characteristics of Expert Systems- Knowledge base, inference engine, explanation facilities, learning capabilities
24. SSAC - Features of Expert Systems-Performance improvement over time, reasoning and decision- making capabilities
25. SSAC - Applications of Expert Systems in Precision Agriculture- Disease Diagnosis, Irrigation Scheduling, and Fertilizer Management
26. SSAC - Importance of Expert Systems in Precision Farming-Decision Support, Efficiency Improvement, and Resource Optimization, Automation in decision-making, reducing human error, increasing efficiency
27. SSAC - Rule-Based System- Architecture- Structure and functioning of rule-based systems, forward and backward chaining

28. SSAC - Software Agents in Agriculture - Definition, Role of Autonomous Agents, Data Processing, and Application in Precision Farming, intelligent behaviour.
29. SSAC - Introduction to Block Chain Concepts in Agriculture- Definition, Overview, and Application in Supply Chain, Traceability, and Data SecurityImpact of Block Chain on Precision Farming- Smart Contracts, Secure Data Transactions, and Farm-to-Market Transparency
30. SSAC - Introduction to Probability and Statistics- Definitions, Overview of probability, random variables, probability distributions Role in Data Analysis, and Application in Precision Agriculture, Bayes Theorem and its Application in Precision Farming-Conditional Probability, Decision- Making, and Risk Assessment in Crop Management
31. SSAC - Correlation and Covariance in Precision Farming Data Analysis- Relationships between Variables, Data Patterns, and Precision Insights
32. SSAC - Continuous Random Variables and Probability Distribution Functions-Probability Distributions: Normal, Poisson, and their Relevance in Agriculture
33. SSAC - Central Limit Theorem and its Importance- Explanation, Applications in Data Aggregation, and Predictive Modeling
34. SSAC - Basics of Machine Learning in Precision Farming-Introduction to Machine Learning Algorithms and Their Applications, Random Forest Algorithm for Agricultural Data Analysis- Concepts, Feature Importance, and Application in Crop Classification and Prediction
35. SSAC - Support Vector Machines (SVM) in Precision Agriculture-Explanation of SVM, Applications in Disease Detection and Crop Monitoring Ensemble Methods in Machine Learning for Agriculture- Bagging, Boosting, Stacking, and their Applications in Precision Agriculture
36. AGRO - Basics of Deep Learning in Precision Farming- Introduction to Neural Networks, CNN, RNN, and Deep Learning Applications in Agriculture,
37. SSAC- Deep Learning Models in Agriculture- Data Preparation, Model Training, Hyperparameters, and Overfitting/Underfitting
38. SSAC - Application of remote sensing in various fields- Agriculture, forestry, weather monitoring, crop area estimation, flood mapping etc.
39. AGRO - Site-specific crop management- Components- Precision nutrition/ irrigation/weeds/crop health- Vegetation indices
40. SSAC - Applications of Remote Sensing in Soil properties soil fertility variability mapping for precision farming Land Use-Land cover classification,
41. SSAC - Remote Sensing for Soil Surveys- Soil texture and moisture mapping, erosion detection, salinity monitoring
42. SSAC - Remote Sensing for Crop Stress and Yield Forecasting- Early Stress Detection, Drought Monitoring, and Yield Prediction Techniques
43. SSAC - Hyperspectral Remote Sensing Soil Analysis- Definition, Importance in Crop Monitoring, and Soil Nutrient Mapping
44. SSAC - Thermal Remote Sensing Applications in Irrigation Management and Crop Stress Monitoring
45. AGRO - Proximal Soil Sensors in Precision Agriculture - Types of Soil Sensors, Soil Nutrient Monitoring, and Applications; Plant Canopy Sensors, Nutrient Deficiency Monitoring, and Canopy Cover Analysis
46. AGRO - Future Trends in Precision Farming- IoT, Robotics, Big Data, and Automa-

tion in Agriculture

47. AGRO - Introduction to Artificial intelligence, Robotics and their applications in precision farming
48. AGRO - Nano technology, definition and concepts and techniques - Nanofertilizers- Nanoherbicides - Nanosensors - Application of nanotechnology in Precision agriculture

Practicals

1. SSAC - Familiarization with Remote Sensing Equipment- Overview of different remote sensing instruments (optical, thermal, and microwave sensors), operation, data acquisition
2. SSAC - Remote Sensing Data Products- Understanding different types of remote sensing data products (multispectral, hyperspectral, LiDAR, radar), resolution (spatial, temporal, spectral), data formats (GeoTIFF, HDF)
3. SSAC - Interpretation of Aerial Photographs- Techniques for aerial photo interpretation, understanding scale, distortions, and relief displacement, identification of land features (vegetation, water bodies, infrastructure)
4. SSAC - Satellite Data Interpretation for Land Resource Mapping- Identification of land use/land cover (LULC), vegetation indices (NDVI, SAVI), classification techniques (unsupervised vs supervised classification), mapping of forests, agriculture, water bodies
5. SSAC - Introduction to Global Positioning System (GPS)- Basics of GPS, how GPS works (satellite triangulation), GPS receiver operation, collecting ground control points (GCPs), GPS accuracy, differential GPS
6. SSAC - Fieldwork with GPS-Hands-on GPS data collection in the field, waypoints, tracks, and routes, integrating GPS data into GIS
7. SSAC - Basics of Geographic Information System (GIS)-Introduction to GIS, understanding spatial and attribute data, layers, data models (vector vs raster), GIS software (QGIS, ArcGIS)
8. SSAC - Georeferencing with Toposheets- Introduction to georeferencing, assigning real-world coordinates to digital maps (toposheets), transformation methods, rectifying errors, understanding projection systems
9. SSAC - Digital Soil Mapping Using Remote Sensing- Use of satellite imagery and GIS for soil mapping, analyzing soil properties (texture, moisture, salinity), mapping soil variability across regions
10. SSAC - Digital Soil Mapping with Different Variables- Integration of various soil variables (pH, organic matter, nutrients) in digital maps, using remote sensing and field data for soil health assessment
11. AGRO - Fertilizer recommendations based on VRT and STCR techniques.
12. AGRO - Crop stress monitoring using geospatial technology, Use of UAVs for assessing crop damage
13. AGRO - Conduct of Agricultural surveys and watershed management using GPS
14. SSAC - Use of GPS for Crop yield estimation.
15. SSAC - Geostatistics in Agricultural Studies-Introduction to geostatistics, spatial interpolation (Kriging, Inverse Distance Weighting), analyzing spatial variability in soil and crop data- Practical implementation of PCA, regression, clustering, and geostatistical methods using software (R, Python, QGIS, ArcGIS), real-world case studies in agriculture

16. AGRO - Creation of productivity and management zones

Suggested readings

1. Data Analytics in Bio informatics: 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 AEl-Kader, MSherine, Mel- Basioni and M Basma.
5. Principles and Theory of Geoinformatics by P.K. Garg. Khanna Publishers. 296p
6. Advances in Geo informatics Remote Sensing and GIS by Bhunia, Gouri Sankar, Uday Chatterjee and Gopal Krishna Panda. BIOGREEN.
7. Artificial Intelligence: Machine Learning, Deep Learning, and Automation Processes by John Adamssen. Efalon Acies.
8. Remote Sensing and Image Interpretation, Lilisand, 6th edn (WSE) Paperback–1 January 2011, Willey Student Edition.
9. Remote Sensing and Geographic Information by A.M. Chandra and S.K. Ghosh.

BIO CHEMISTRY

BICM 301
ESSENTIALS OF PLANT BIOCHEMISTRY
2 (1+1)

Objective

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

Course Outlines

Theory

Biochemistry - Introduction and importance, Properties of water, pH and buffer 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 - Intermediory - Metabolism. 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 valueand iodine number, Estimation of ascorbic acid, Qualitative/ quantitative tests of secondary metabolites.

Lecture Outlines

Theory

1. Definition and Scope of Biochemistry, Historical Developments of Biochemistry, Application of Biochemistry in Medicine, Agriculture, and Nutrition
2. Structure and Unique Properties of Water, Role of Water in Biochemical Reactions, Concept of pH and its Biological Significance, Buffer Systems (Bicarbonate, Phosphate Buffers), Henderson- Hasselbalch Equation.
3. Classification of Carbohydrates - Monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides - Structure and Biochemical importance; Optical activity of sugars, Stereochemical properties of monosaccharide, Pyranose & furanose structure, Mutarotation - Anomers, Reducing properties of sugars, Biological Roles of Carbohydrates (Energy Storage, Structural Components).
4. General Structure of Amino Acids, Classification & function of Amino Acids Based on R-Group Characteristics, Essential vs. Non-Essential Amino Acids, Physical properties (Solubility, Optical properties, Zwitterion, Isoelectric point), Acid-Base behaviour- Titration curve: Non-standard Amino acids, Biologically important peptides.
5. Primary, Secondary (Alpha Helix and Beta Sheet Structures in Proteins), Tertiary and Quaternary Structures of Proteins, Types of Bonds and Forces Stabilizing Protein Structure, Structural Domains and Motifs in Proteins; Importance of Protein Folding and Denaturation.
6. Classification of Proteins: Simple, Conjugated, Derived Proteins; Functional classification of Proteins; Nutritional classification of protein; isoelectric PH, Precipitation

by salting out, Denaturation, Protein Degradation and Turnover.

7. Classification of Lipids: Simple, Compound, and Derived Lipids; Biological Functions of Lipids: Structure of fatty acids; Essential fatty acids; Structure of Triacylglycerol, Phospholipids, Sterols; Tests to check purity of fats and oils (Saponification number, Acid number, Iodine number), Lipid Peroxidation, Rancidity.
8. Functions of Nucleic acids; Structure of Nucleotides; Classification of Nucleic Acids: DNA vs. RNA; Structure of DNA & RNA; Denaturation of DNA Strands - Melting temperature.
9. Overview of Water-Soluble Vitamins (B-Complex, Vitamin C); Metabolic Functions: Coenzymes in Energy Metabolism; Deficiency Symptoms; Dietary Sources and Recommended Daily Allowances (RDA).
10. Overview of Fat-Soluble Vitamins (Vitamins A, D, E, K); Absorption, Transport, and Storage of Fat- Soluble Vitamins; Biological Functions, Deficiency Symptoms and Associated Disorders, Dietary Sources and RDA.
11. Definition, Importance of enzymes; Classification of enzymes with reactions; Properties of Enzymes – Enzyme specificity: Features of Active Site; Cofactors and Coenzymes.
12. Mechanism of Enzyme Action: Lock-and-Key vs. Induced Fit Models; Mechanism of enzyme action by lowering activation energy; Mechanism of enzyme catalysis; Factors affecting enzyme activity – Concentration of Enzyme, Substrate, Effect of temperature, pH & product concentration; Feedback Inhibition and Its Role in Metabolic Pathways.
13. Michaelis-Menten Kinetics - Km and Vmax; Enzyme inhibition - Irreversible inhibition, Reversible inhibition - Types of Enzyme Inhibition: Competitive, Non-Competitive, Uncompetitive - Double Reciprocal (Lineweaver-Burk) Plot for Enzyme Kinetics; Interpretation of Km and Vmax from Lineweaver-Burk Plot.
14. Definition and Properties of Allosteric Enzymes; Allosteric Regulation: Positive and Negative Modulators; Sigmoidal Kinetics vs. Michaelis-Menten Kinetics; Role of Enzymes in Food Processing, Brewing & Dairy, Textile and Detergent Industry.
15. Definition and Importance of Metabolism; Types of Metabolism: Anabolism and Catabolism; Overview of Bioenergetics: Concept of Free Energy (ÄG), Entropy, Enthalpy; ATP - The Energy Currency of the Cell; Energy-rich Compounds: NADH, FADH, , GTP; Oxidation-Reduction Reactions; Overview of intermediary metabolism.
16. Importance of Secondary Metabolites in plant defence; Alkaloids - heterocyclic secondary metabolites, their ecological significance; Terpenoids - Precursors, Example & their multiple functions in plant metabolism; Phenolics – Functions of phenylpropanoids, role as secondary cell wall components, Functions of flavonoids; Applications of Secondary Metabolites in Food and Pharmaceutical Industries, Therapeutic Potential of Secondary Metabolites.

Practicals

1. Preparation of standard solutions and reagents.
2. Determination of pH and Buffer preparation.
3. Qualitative tests for carbohydrates.
4. Qualitative tests for amino acids.
5. Quantitative estimation of soluble sugars.
6. Quantitative estimation of starch.

7. Estimation of protein by Kjeldhal method.
8. Estimation of soluble protein by Lowry's method.
9. Preparation of mineral solution from ash.
10. Estimation of fat by Soxhlet method.
11. Determination of acid value.
12. Determination of saponification value.
13. Determination of iodine number.
14. Estimation of ascorbic acid.
15. Qualitative tests of secondary metabolites.
16. Quantitative estimation of secondary metabolites.

Suggested Readings

1. Nelson and Cox, 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman.
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.
4. Heldt, 2005. Plant Biochemistry. Elsevier.
5. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd Edition. CBS.

ELCT 422
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

Course Outlines

Theory

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

Practical

Water quality analysis - physico, chemical and microbiological. Preparation of different types of media. Microbiological examination of different food samples - Assessment of surface sanitation by swab/rinse method - Assessment of personal hygiene - Biochem-

ical tests for identification of bacteria - Scheme for the detection of food borne pathogens - Preparation of plants for Implementation of FSMS-HACCP, ISO:22000.

Lecture Outlines

Theory

1. BICM - Introduction to Food Safety - Importance of Food Safety in Public Health, Scope of Food Safety in the Food Industry
2. BICM - Factors Affecting Food Safety - Factors influencing food safety (biological, environmental, handling), Foodborne Illnesses: Common examples and their impact
3. BICM - Food Hazards and Risks - Definition of Hazards and Risks in Food Safety, Differentiating between hazards and risks
4. BICM - Types of Hazards in Food Safety - Biological Hazards: Bacteria, viruses, fungi, parasites; Potential risks of foodborne bioterrorism, Bioterrorism protection, The role of pest management in biosecurity
5. BICM - Chemical Hazards in Food Safety - Food additives, toxins, allergens, Pesticides, heavy metals, and environmental contaminants; True Food Allergy, Food Intolerance, Regulatory requirement, Allergen Management, Ingredients, Production, Packaging and Labeling, Sanitation and Allergen Control, Disposition/Liability
6. BICM - Physical Hazards in Food Safety - Foreign materials (glass, plastic, metal, etc.), Detection and prevention methods. Sanitation Role in Physical Hazard Prevention
7. BICM - Hazard Management in Food Safety - Importance of Hazard Management, Overview of Hazard Control Strategies
8. BICM - Control Parameters in Food Safety - Critical control points (CCPs) in the food production process, Control parameters: Temperature, time, pH, etc.
9. BICM - Temperature Control in Food Safety - Importance of temperature in preventing foodborne illness, Refrigeration, freezing, cooking, and hot holding standards
10. BICM - Food Storage Guidelines - Principles of safe food storage, Types of storage: Dry, cold, and frozen, FIFO (First In, First Out) method , Low- Moisture Food Manufacturing and Storage Sanitation, Sanitary construction considerations, Receipt and storage of raw materials, Cleaning of low-moisture food manufacturing plants
11. BICM - Production Design for Food Safety - Plant layout and design considerations, Prevention of cross- contamination; Principles of sanitary facility design
12. PATH - Hygiene and Sanitation in Food Service Establishments - Introduction to hygiene and sanitation in food service, Importance in maintaining food safety
13. PATH - Sources of Contamination and Control - Common sources of contamination (air, water, equipment), Transfer of contamination, Protection against contamination.
14. PATH - Waste Disposal in Food Safety - Safe disposal of food waste, Impact of waste on food safety and environment; Strategy for waste disposal. Planning the survey, Solid waste disposal, Liquid waste disposal
15. PATH - Pest and Rodent Control in Food Establishments - Types of pests and their impact on food safety, Integrated pest management (IPM) strategies
16. PATH - Personnel Hygiene in Food Safety - Role of food handlers in preventing contamination, Personal hygiene practices and regulations
17. BICM - Food Safety Measures - Overview of food safety measures, Preventative practices in food establishments
18. BICM - Introduction to Food Safety Management Tools - Overview of food safety

management systems, Key terms: PRPs, GHPs, GMPs, SSOPs
19. BICM - Good Hygiene Practices (GHPs) - GHPs in food service establishments, Specific practices for personal and facility hygiene
20. BICM - Good Manufacturing Practices (GMPs) - GMP guidelines for food production, Importance in maintaining product quality- Employee GMPs
21. BICM - Sanitation Standard Operating Procedures (SSOPs) - Importance of SSOPs in food safety, Key components of effective SSOPs
22. BICM - Hazard Analysis and Critical Control Point (HACCP) - Introduction to HACCP principles, HACCP as a food safety management tool
23. BICM - Steps for implementing HACCP in food production, Developing a HACCP plan
24. BICM - ISO Series and Food Safety Management - Overview of ISO standards related to food safety, Role of ISO 22000 in food safety management
25. BICM - Total Quality Management (TQM) in Food Safety - Introduction to TQM, Concept of continuous improvement (Kaizen) in food safety; The role of total quality management, Quality assurance for effective sanitation; Quality assurance program
26. BICM - Components of TQM in food production, Importance of employee involvement in TQM
27. BICM - Risk Analysis in Food Safety - Risk assessment, management, and communication, Role of risk analysis in food safety decision-making
28. BICM - Accreditation and Auditing in Food Safety - Importance of food safety accreditation and certification, Conducting internal and external food safety audits
29. BICM - Water Analysis in Food Safety - Importance of water quality in food safety, Water testing methods and standards
30. PATH - Surface Sanitation and Personal Hygiene - Importance of surface sanitation in preventing contamination, Methods of surface sanitation; Effects of surface characteristics on soil deposition, Soil attachment characteristics, Cleaning compound characteristics, Classification of cleaning compounds Cleaning auxiliaries, Scouring compounds,
31. BICM - Food Laws and Standards: Introduction - Overview of global and national food safety laws, Role of regulatory agencies in food safety; Sanitation Regulatory Requirements, FDA, Food Safety Modernization Act of 2011, USDA, Sanitation Standard Operating Procedures (SSOPs), Sanitation Performance Standards (SPSs), European Food Safety Authority.
32. BICM - Indian Food Regulatory Regime: FSSA - Introduction to the Food Safety and Standards Act (FSSA), FSSAI guidelines and regulations
33. BICM - Global Scenario: Codex Alimentarius Commission (CAC) - Role of the Codex Alimentarius in food safety, International food standards set by CAC
34. BICM - Other Food Laws and Standards - Overview of other food-related laws (e.g., Consumer Protection Act, Packaging Laws), Food safety standards in different countries
35. PATH - Emerging Concerns: New Pathogens - Identification of new and emerging pathogens, Recent foodborne outbreaks caused by pathogens, Control of Listeria in food manufacturing, Biofilm formation, Removal of Biofilms
36. PATH - Packaging and Food Safety - Role of packaging in food safety, Types of packaging materials and their safety concerns
37. BICM - Product and Nutritional Labelling - Importance of accurate labelling for food

safety, Requirements for nutritional labelling

38. BICM - Genetically Modified Foods (GMOs) and Food Safety - Overview of GM foods, Safety and labelling regulations for GM foods
39. BICM - Organic Foods and Food Safety - Defining organic foods and their safety concerns, Organic certification standards.
40. BICM - Newer Approaches to Food Safety - Introduction to innovative technologies (e.g., nanotechnology, blockchain), Role of emerging technologies in improving food safety
41. BICM - Case studies of recent foodborne illness outbreaks, Analysis of causes and preventive measures
42. BICM - Food Safety Standards for Dairy and Meat Products - Specific food safety standards for animal- derived products, Role of veterinary controls in food safety
43. BICM - Food Safety Standards for Plant- Based and Fermented Products - Food safety concerns for plant- based foods, Food safety management for fermented foods
44. BICM - Food Safety in Marine Products - Hazards associated with marine and sea-food products, International standards for seafood safety
45. BICM - Food Safety and Public Health - Role of food safety in preventing public health crisis, Impact of food safety measures on population health
46. BICM - Recent Concerns in Food Safety: Nanotechnology and Food Safety - Nano-technology applications in food safety, Regulatory concerns and potential risks
47. BICM - Food Safety and the Global Trade - Importance of food safety in international trade
48. BICM - Challenges faced by exporting and importing countries

Practicals

1. BICM - Analyze the basic physico-chemical & microbiological properties of water samples.
2. PATH - Assess the microbiological quality of water by detecting coliforms.
3. PATH - Preparation of different types of culture media
4. PATH - Microbiological examination of milk.
5. PATH - Microbiological examination of fruits and vegetables.
6. PATH - Microbiological examination of processed food samples.
7. PATH - Assessment of surface sanitation by swab method.
8. PATH - Assessment of surface sanitation by rinse method.
9. BICM - Assessment of personal hygiene
10. BICM - Biochemical tests for identification of bacteria (Iodine test, Citrate test, Urease test).
11. BICM - Biochemical tests for identification of bacteria (Catalase test, Coagulase test, Oxidase test).
12. PATH - Isolation of Salmonella from poultry products using selective enrichment.
13. PATH - Isolation of Escherichia coli from raw meat products.
14. PATH - Scheme for the detection of food borne pathogens
15. BICM - Identification of critical control points in food processing
16. BICM - 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.

ELCT 425
FOOD SCIENCE AND NUTRITION
4 (3+1)

Objectives

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

Course Outlines

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; Physiochemical, 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/ Oxalate, Trypsin and Chymotrypsin inhibitor activities, limiting amino acids in food stuff.

Lecture Outlines

Theory

1. Introduction on fundamentals of foods and human nutrition - Definition of food, nutrients, nutrition and health, specific nutrients in foods and their functions.
2. Basic food groups - Types of basic food groups (grains, vegetables, fruits, pro teins, dairy products) and their nutritional facts.
3. Concept of balanced diets - Definition, importance of balanced diet, health benefits and risks of imbalanced diets.
4. Recommended Daily Allowances (RDA) - Definition, calculation of RDA, signifi cance of RDA for different age groups based on sex, age, activity level and phys iological state.

5&6. Biochemical composition of grains and pulses - Energy and food value of vari ous food grains, fruits and vegetables - Nutritional contribution to diet.

7&8. Carbohydrates, proteins, fats as nutrients and their interactions - Carbohy

drates as nutrients - Definition, types of carbohydrates.

9. Proteins as nutrients - Definition, types of proteins.

10. Fats and Lipids as nutrients - Definition, types of fats (saturated, unsaturated, trans fats) - Relation between the metabolism of carbohydrates, proteins and fats.

11. Physiochemical, functional and nutritional characteristics of essential nutri ents, sources and functions - Physiochemical characteristics of carbohydrates, dietary sources and biological functions of carbohydrates (energy storage, gly cemic index and glycemic load).

12. Physiochemical characteristics of proteins, dietary sources and biological func tions of proteins (emulsification, gelation, foaming, importance in muscle, en zyme, and hormone synthesis).

13. Physiochemical characteristics of fats, dietary sources and biological functions of fats (emulsification, lipid solubility and energy storage).

14. Nutritional requirements - Among different age groups, impact of age on nutri ent absorption and metabolism.

15&16. Malnutrition - Definition, causes and symptoms of kwashiorkor and maras mus - Differences between kwashiorkor and marasmus, prevention and treat ment strategies.

17. Inborn errors of metabolism - Definition of inborn errors of metabolism, com mon Examples (Phenylketonuria, Lactose Intolerance).

18. Deficiency diseases - Micro nutrient deficiencies (Iron, Iodine), vitamin deficiencies, prevention strategies (fortification, supplementation).

19. Digestion, absorption, transport of nutrients - Digestion of carbohydrates, en zymes involved in carbohydrate digestion, absorption of simple sugars in the small intestine.

20. Digestion of proteins, enzymes involved in protein digestion (gastric and pan creatic enzymes) amino acid absorption and transport.

21. Digestion of fats - enzymes involved in fats digestion (Lipase activity) and fat absorption in the small intestine, transport of lipids (Chylomicrons, Lipopro teins).

22&23. Metabolism of nutrients - Overview of anabolism and catabolism, Inter con version of nutrients (Gluconeogenesis, Lipogenesis).

24. Protein quality evaluation - Methods and importance - Biological value and Net protein utilization.

25. Biochemical and nutritional aspects of water - soluble vitamins - Sources and functions of water - soluble vitamins and their deficiency symptoms.

26. Biochemical and nutritional aspects of fat - soluble vitamins - Sources and functions of fat - soluble vitamins and their deficiency diseases.

27&28. Minerals - Macro and micro minerals in foods sources, functions and their defi ciency diseases.

29. Nutraceuticals - Definition, food sources, importanceof nutraceuticals in diet, health benefits of nutraceuticals.

30&31. Antioxidants in foods - Definition, food sources, role in preventing oxidative stress, importance of antioxidants in diet - Antinutritional factors - Definition, food sources, types of antinutritional factors (Phytates, Oxalates).

32&33. Biochemistry of post - harvest storage of food grains - Nutritional losses

during processing of grains, fruits and vegetables (milling, peeling and cook ing on nutrients) - Strategies to minimize nutritional losses.

34. Effects of cooking on nutrient composition of foods - Impact of heat, water and light on nutrients.
35. Cooking effects on carbohydrates, proteins, and fats - Nutrient preservation in cooking methods - Energy density and caloric value.
36. Processing and preservation of nutrients of different food products - Causes of spoilage of food - Factors contributing to spoilage (temperature, moisture), food preservation impact on nutrient retention.
37. Effect of preservation on vitamins, minerals and antioxidants - Food preserva tion methods (canning, freezing, drying).
38. Food Fads and Myths - Common food fads and misconceptions, importance of evidence - based nutrition - Food safety standards - National and International
39. Perspectives - Overview of food safety regulations (FSSAI, FDA, Codex).
40&41. Foodborne Illnesses and prevention strategies - Importance of food safety for public health - Food quality control and certification systems, Role of quality standards in nutrition security - Measures for ensuring food quality.
42. Role of enzymes in food industry - Enzyme applications in food processing (amylases, proteases), role of enzymes in fermentation and preservation.
43. Food additives - Definition, common types of food additives (preservatives, col orants, emulsifiers).
44. Nutritional quality of plant - based foods - grains and vegetables - Role of vege tables in disease prevention.
45. Nutritional quality of animal - based foods - meat, poultry and dairy - Nutritional benefits of meat and dairy in diet.
46. Nutritional quality of marine products - fish and seafood, omega - 3 fatty acids and heart health benefits - Nutritional comparison of different seafood types.
47&48. Nutritional quality of fermented foods - Overview of fermented foods (Yogurt, Sauerkraut, Kimchi) - Future directions in food and nutrition, current trends in food science and nutrition research.

Practicals

1. Determine the moisture content of a food sample using oven drying or moisture analyzer
2. Estimate the total ash content in food.
3. Estimate the crude fat content in food using Soxhlet extraction.
4. Determine the crude protein content of food using the Kjeldahl method.
5. Estimate the crude fiber in food by acid and alkaline digestion.
6. Measure the calorific (energy) value of a food sample using a bomb calorimeter.
7. Estimate the vitamin C (ascorbic acid) content in food using iodine titration.
8. Measure the total phenolic content in a food sample.
9. Measure the total flavonoid content in food using a colorimetric method.
10. Estimate the total carotenoid content in food using solvent extraction.
11. Estimate the phytate (antinutrient) content in a food sample using the Wade reagent.
12. Estimate oxalate content in food using titration.
13. Measure trypsin inhibitor activity in a food sample using enzyme inhibition assay.
14. Measure chymotrypsin inhibitor activity in a food sample.

15. Determine the limiting amino acid (e.g., lysine) in a food sample using chromatography or chemical methods.
16. Estimate methionine content in food using a chemical method (e.g., performic acid oxidation).

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.

ENTOMOLOGY

ENTO 131
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 insecta 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

Course outlines

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 Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect body wall and moulting. Body segmentation. Structure of head, thorax and abdomen. Structure and modifications of insect antennae, mouthparts, legs, Wing venation, modifications and wing coupling apparatus. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system in insects. Types of reproduction in insects. Major sensory organs. Insect Ecology: 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, Lophopidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Pieridae, Papilionidae, Lycaenidae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tephritidae Agromyziidae, Muscidae, Tachinidae, Culicidae.

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.

Lecture Outlines

Theory

1. History of Entomology in India, Contributions of eminent Entomologists, Locations and year of establishment of Entomological institutions. Arthropoda - Mention of insects in scripts. Contributions of Aristotle, J.C. Fabricius, J.G. Koenig, Carolus Linnaeus, Cramer, Dury, Dr. Kerr, Rev. Hope,Rothney, Ronald Ross, L De Niceville, H.M. Lefroy, T.B.Fletcher, E.P. Stebbing, T.V. Ramakrishna Ayyar, B.V. David, Y.Ramachandra Rao, M. S. Mani, S. Pradhan, H.S. Pruthi, M.R.G.K. Nair; M. L. Roonwal, T. Kumara Swami, K. K. Nayar, N. Ananthakrishnan and C. A. Viraktamath. Locations and year of establishment of Division of Entomology, IARI, Zoological Survey of India (ZSI), Directorate of Plant Protection, Quarantine and Storage (DPPQS), National Institute of Secondary Agriculture (NISA), National Bureau of Agricultural Insect Resources (NBAIR), National Institute of Plant Health Management (NIPHM), National Centre for Integrated Pest Management (NCIPM) and Forest Research Institute (FRI), National Institute of Biotic Stress Management (NIBSM) and Central Silk Board (CSB).
2. Contributory factors for abundance of insects - Major structural characters, developmental characters and protective characters (Morphological, physiological, behavioural and construction of protected niches) of Insecta in Animal Kingdom.
3. Classification of Phylum Arthropoda up to Classes - Different Classes of Arthropoda and comparison of characters of Class Insecta with Arachnida, Crustacea, Symphyla, Chilopoda and Diplopoda and Onychophora.
4. Structure and functions of body wall/Integument - Different layers- Basement membrane, Epidermis and Cuticle and moulting -, chemical composition, and functions of body wall and cuticular appendages.Cuticular processes and cuticular invaginations - Chaetotaxy. Moulting - Apolysis, ecdysis and sclerotization.
5. Body segmentation of the insects- Head (Syncephalon) - Procephalon and gnathocephalon, types of head, sclerites and sutures. Thorax - Segments, sclerites and appendages (Wings and legs).
6. Abdomen - Segments, sclerites, pre and post genital appendages (Furcula, cornicles, tracheal gills and pseudoovipositor in Diptera - Propodeum, petiole and gaster in Hymenoptera). Male and female genital organs - Epimorphic and anamorphic development in insects.
7. Antenna - Structure of typical antenna and its modifications in different insects with examples.
8. Mouthparts - Biting and chewing, sucking (Piercing and sucking, Rasping and sucking, Chewing and lapping, Sponging and Siphoning/ Simple sucking), Mask and Degenerate types with examples.
9. Legs - Structure of a typical insect leg and modifications of insect legs with examples.
10. Wings - Areas, venation, margins and angles-Types of wings and wing coupling organs with examples.
11. Types of Metamorphosis and diapause-Metamorphosis- Ametamorphosis - Incomplete Metamorphosis or Direct or Simple Metamorphosis- Intermediate metamorphosis - Complete Metamorphosis or Complex or Indirect Metamorphosis - Hypermetamorphosis with examples. Diapause-Obligate and facultative diapauses - Stage of occurrence of diapause with examples.

12. Types of larva and pupa - Differences between nymph and larva - Larva- Protopod-Oligopod (Campodeiform and Scarabaeiform)- Polypod and Apodous with examples. Pupa- Obtect-Chrysalis, Exarate and Coarctate- with examples.
13. Digestive system - Alimentary canal - Structure of foregut, midgut and hindgut - histology, functions, filter chamber and peritrophic membraneProcess of digestion-Extra intestinal digestion.
14. Circulatory system - Open and closed types - Organs of circulatory system - Dorsal blood vessel (Diaphragms, sinuses and accessory pulsatile organs). Process of circulation, Types of haemocytes, Properties and functions of haemolymph.
15. Excretory system - Structure, functions and modifications of malpighian tubules. Structure and functions of other organs of excretion
16. Respiratory system - Tracheal system - Structure of spiracle and trachea Classification based on functional spiracles and other means of respiration
17. Nervous system - Neuron and its types based on structure and function. Synapse, ganglia, central nervous system, sympathetic nervous system and peripheral nervous system
18. Secretory (Endocrine) system - Structure and functions of neurosecretory organs (neuro secretory cells of brain, corpora cardiaca, corpora allata, prothoracic glands and ring gland).
19. Reproductive system - Structure of male and female reproductive systems - Structure and types of ovarioles and structure of follicle - Types - Special modes of reproduction in insects
20. Sense organs - Compound eyes - Structure of ommatidium, Ocelli - Dorsal ocelli and lateral ocelli - Types of images and auditory organs (Auditory hairs, tympanum, Jhonston's organ and pilifer organ). Chemoreceptors.
21. Taxonomy - Importance - History and Development-Binomial nomenclature - Holotype, allotype and paratype - Suffices of tribes, sub-family, family and superfamily - Law of priority - Synonyms and homonyms - Definitions of biotype - Subspecies - Species – Genus - Family and Order. Characters of Class Insecta - Economic classification of insects - Classification up to Orders - Subclasses - Apterygota and Pterygota - Orders of Apterygota and Pterygota with examples
22. Orthoptera - General characters - Acrididae, Tettigonidae, Gryllidae and Gryllotalpidae - Characters with examples
23. Dictyoptera - General characters - Blattidae and Mantidae - Characters with examples - Odonata - General characters with examples
24. Isoptera - General characters - Termitidae - Characters with examples. Thysanoptera - General characters - Thripidae - Characters with examples.
25. Hemiptera - General characters - Sub order Heteroptera - Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Miridae and Cimicidae - Characters with examples.
26. Hemiptera - Suborder Homoptera - Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophopidae, Aleurodidae, Pseudococcidae, - Characters with examples - Neuroptera - General characters - Chrysopidae- characters with examples.
27. Lepidoptera - General characters - Differences between moths and butterflies - Noctuidae, Sphingidae and Pyralidae - Characters with examples.
28. Lepidoptera- Gelechiidae, Lycaenidae, Arctiidae, Papilionidae, Pieridae, Bombycidae and Saturniidae - Characters with examples.
29. Coleoptera - General characters - Coccinellidae, Chrysomelidae, Scarabaeidae -

Characters with examples.

30. Coleoptera - Cerambycidae, Bruchidae and Curculionidae - Characters with examples.
31. Hymenoptera-General characters - Tenthredinidae, Apidae, Ichneumonidae, Braconidae, Chalcididae and Trichogrammatidae - Characters with examples.
32. Diptera -General characters - Cecidomyiidae, Agromyzidae, Muscidae, Tephritidae, Tachinidae and Culicidae- Characters with examples.

Practicals

1. Methods of collection and preservation of insects including immature stages
2. External features of Grasshopper / Blister beetle
3. Study of different types of insect antennae
4. Study of different types of insect mouthparts
5. Study of different types of insect legs
6. Study of wing venation, types of wings and wing coupling mechanisms
7. Study of different types of insect larva and pupa
8. Dissection of digestive system in insects (Grasshopper).
9. Study of characters of Orders - Orthoptera, Dictyoptera and their families
10. Study of characters of Orders - Isoptera, Thysanoptera. and their families and characters of Odonata.
11. Study of characters of Order -Hemiptera and its sub order Heteroptera and its families.
12. Study of characters of Sub Order - Homoptera and its families
13. Study of characters of Order- Neuroptera and Lepidoptera and their families
14. Study of characters of Order- Coleoptera and its families.
15. Study of characters of Order- Hymenoptera and its families
16. Study of characters of Order - Diptera and its families

Suggested readings

1. Chapman, R. F 2013 The Insects: Structure and Function(Fifth edition). Ed by Simpson, S. J. and Douglas, A C. Cambridge Univ. Press, UK.
2. Charles A Triplehorn and Norman F. 2005.Borror and De Long's Introduction to the Study of Insects.Johnson Thomson Brooks/Cole Publishing. U.S.A.
3. Kapoor, V. C 2008. Theory and Practice of Animal Taxonomy(Sixth edition).Oxford and IBH Publishing, New Delhi.
4. Pant, N.C. and Ghai, S. 1973. Insect Physiology and Anatomy, ICAR, New Delhi.
5. Richards, O.W. and Davies, R.G 1977. Imm's General Text Book of Entomology (Vol. I and II). (Tenth edition). Chapman and Hall, London.
6. Snodgrass, R.E. 2004.Principles of Insect Morphology. CBS Publishers & Distributors, Delhi.
7. Timbhare, D.B. 2015.Modern Entomology, Himalaya Publishing House, Bengaluru.
8. Wigglesworth, V.B.2013.Insect Physiology (Eighth edition). Springer, New York (Originally published by Chapman and Hall, London, 1974).

ENTO 231
INSECT ECOLOGY AND CONCEPTS OF INTEGRATED PEST MANAGEMENT
2 (1 +1)

Objectives

1. To know the influence of ecological factors on insect development and distribution
2. To understand the tools and concepts of Integrated Pest Management
3. To know about different biocontrol agents and their mass multiplication viz., predators, parasitoids, EPF and NPV
4. To know the classification, formulations of insecticides and their use in pest management

Course outlines

Theory

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance. Concepts of Balance of Life in nature, Biotic Potential and Environmental Resistance and causes for outbreak of pests in agro-ecosystem. Pest surveillance and pest forecasting. Categories of pests. IPM: Concepts, Host plant resistance, components/tools of IPM: Cultural, Mechanical, Physical, Legislative, Biological (Important parasitoids, predators, transgenic plants, pathogens such as bacteria, fungi, EPNs and viruses). Chemical control - importance, hazards and limitations. Classification of insecticides, toxicity of insecticides, brief mode of action of different groups of insecticides used in crop pest management - label claim of insecticides. Biorational insecticides, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes, Insecticides Act 1968.

Practical

Study of distribution patterns of insects in crop ecosystems - Sampling techniques for the estimation of insect population and damage - Pest surveillance through light traps, pheromone traps and forecasting of pest incidence - Calculation of doses/ concentrations of different insecticidal formulations - Acquaintance of insecticide formulations – Compatibility of pesticides with other agrochemicals and phytotoxicity of insecticides – Pesticide appliances and their maintenance - Acquaintance of mass multiplication techniques of important predators : Cryptolaemus. Important parasitoids: Egg, larval and pupal parasitoids viz., Trichogramma, Apanteles and Tetrastichus. Important Entomopathogenic Fungi: Beauveria bassiana and Nuclear Polyhedrosis Virus (NPV) on Helicoverpa and Spodoptera. Study of insect pollinators, weed killers and scavengers - Identification of major non-insect pests viz., birds, rodents, crabs, snails, slugs and mammalian pests. Household and veterinary insect pests.

Lecture Outlines

Theory

1. Insect Ecology- Introduction, Autecology and Synecology-Population-Community Ecosystem-Agro- ecosystem -Environment and its components. Abiotic factors -Temperature- Its effect on the development, fecundity, distribution, dispersal and movement of insects-Adaptations of insects to temperature - Thermal constant-Day Degrees. Moisture- Adaptation of insects to conserve moisture. Humidity- Its effect

on development, fecundity and colour of body -Rainfall - Its effect on emergence, movement and oviposition of insects.

2. Light – Phototaxis - photoperiodism - Its effect on growth, moulting activity or behaviour, oviposition and pigmentation - Use of light as a factor of insect control; Atmospheric pressure and its effect on behaviour. Air currents - Effect on dispersal of insects –Edaphic factors
3. Biotic factors - Food-Classification of insects according to nutritional requirements - Other organisms - Inter and Intra specific associations - Beneficial and harmful associations of parasitoids based on site of attack, degree of parasitism and food habits. Effect of biotic factors - Competition, natural and environmental resistance
4. Concepts of Balance of life in nature - Biotic potential and environmental resistance - Factors contributing to increase or decrease of population -Causes for outbreak of pests in agro-ecosystem.
5. Practices, Scope and Limitations of IPM - IPM Definitions, Concepts - Economic Threshold Level (ETL) - Economic Injury Level (EIL) and General Equilibrium Position(GEP) - Modified Equilibrium Position (MEP)-Components/tools of IPM.
6. Pest surveillance and pest forecasting - Definition-Importance in IPM - Advantages - Components of pest surveillance, types of forecasting (Short term and long term forecasting and their advantages) - Insect pests - Definitions of negligible, minor and major pests; Different categories of pests - Regular, occasional, seasonal, persistent, sporadic, epidemic and endemic pests with examples.
7. Host-plant resistance - Principles of host plant resistance - Ecological resistance - Phenological asynchrony, induced resistance and escape - Genetic resistance - Mono, oligo and polygenic resistance - Major gene resistance (vertical/ specific/ qualitative) and minor gene resistance (horizontal/ nonspecific/ quantitative) - Host - plant selection process-host habitat finding, host finding, host recognition, host acceptance and host suitability - Mechanisms of Genetic resistance- Non-preference (antixenosis), antibiosis and tolerance - Transgenic plants.
8. Components/ tools of IPM: Cultural control-Normal and special cultural practices which incidentally control the pests and agronomic practices recommended specifically against the insect pests with examples.
9. Mechanical control - Different mechanical methods of pest control with examples. Physical control - Use of inert carriers against stored product insects - steam sterilization - Solarization - Solar radiation - Light traps - Flame throwers etc.; Legislative measures -Importance of quarantine- Examples of exotic pests - Different legislative measures enforced in different countries including India.
10. Biological control - Types of biological control - Introduction, augmentation and conservation - Advantages and disadvantages of biological control. Parasite - Parasitoid - Parasitism - Grouping of parasites based on nature of host, stage of host, site of parasitisation, duration of attack, degree of parasitisation and food habits - Kinds of parasitism - Qualities/attributes of an effective parasitoid. Predators - Predatism - Qualities of insect predator - Differences between predator and parasite.
11. Microbial control - Important groups of microorganisms - Bacteria, viruses and fungi used in pest control and multiplication technique of Bacteria- Transgenic plant pathogens - Entomopathogenic nematodes (EPNs) - Important species- Mode of infectivity and examples
12. Chemical control - Importance and ideal properties of insecticide - Classification of

insecticides based on origin, mode of entry, mode of action and toxicity with list of insecticides - Toxicity evaluation of insecticides - Acute or chronic toxicities, oral and dermal toxicities - LC50 (Median Lethal Concentration), LD50 (Median Lethal Dose), ED50 (Median Effective Dose), LT50 ((Median Lethal time), KD50 (Median Knock down Dose) and KT50 (Median Knock Down Time) - Bioassay methods - Advantages and disadvantages of chemical control

13. Insecticides- Brief mode of action of different groups of insecticides with examples - Organochlorines - DDT and BHC - Cyclodienes - Endosulfan; Organophosphates - Malathion, Monocrotophos, Chlorpyriphos, Phorate, Acephate and Profenophos; Carbamates - Carbaryl and Carbofuran; Synthetic pyrethroids -Deltamethrin, Lambda cyhalothrin, Neonicotinoids- Imidacloprid, Acetamiprid and Thiamethoxam.
14. Novel Insecticides used in crop pest management with brief mode of action - Spinosyns- Spinetoram, Spinosad; Avermectins - Emamectin benzoate, Abamectin; Pyridine Azomethines - Pymetrozine, Thiourea-Diafenthiuron; Pyrroles–Chlorfenapyr; Nereistoxin analogues - Cartap hydrochloride; Benzoyl phenyl Ureas - Novaluron, Pyrazole - Tolfenpyrad; Oxadiazines - Indoxacarb; Diamides - Chlorantraniliprole, Cyantraniliprole, Flubendiamide; Phenyl pyrazole - Fipronil; Ketoenols - Spirotetramat, spiromesifer; Pyridine Carboxamide –Flonicamid; Hydroxy- 4- coumarin - Bromodialone - Label Claim of Insecticides.
15. Biorational Insecticides - repellents (Physical and Chemical) and antifeedants - Importance of antifeedants and limitations of their use - Attractants - Sex pheromones - Synthetic sex pheromones - use in IPM - Insect hormones - Gamma irradiation - Genetic control - Sterile male technique.
16. Application techniques of spray fluids - High volume, low and ultra low volume sprays - Phytotoxic effects of insecticides - Safe use of pesticides. Symptoms of poisoning - First aid and antidotes for important groups of insecticides. Insecticides Act 1968 - Important provisions - Insecticide resistance - resurgence - insecticide residues - importance - Maximum Residue Limits (MRL) - Acceptable Daily Intake (ADI) - Safe waiting periods.

Practicals

1. Sampling techniques for the estimation of insect population in different crops and distribution patterns of insects in crop ecosystems
2. Techniques for the estimation of insect damage in different crops
3. Pest surveillance through light traps, pheromone traps and forecasting of pest incidence
4. Acquaintance of insecticide formulations
5. Calculation of doses/ concentrations of different insecticidal formulations
6. Compatibility of pesticides with other agrochemicals and phytotoxicity of insecticides; insecticides banned, withdrawn and restricted use
7. Pesticide appliances and their maintenance
8. Acquaintance of mass multiplication techniques of important predators – Cryptolaemus
9. Acquaintance of mass multiplication techniques of the egg parasitoid, Trichogramma
10. Acquaintance of mass multiplication techniques of Apanteles sp. (Larval) and Tetrastichussp (Pupal) parasitoids
11. Acquaintance of mass multiplication techniques of important entamopathogenic

fungus, *Beauveria bassiana*
12. Acquaintance of mass multiplication techniques of Ha NPV and Sl NPV.
13. Study of insect pollinators, weed killers and scavengers
14. Identification of different rodent pests
15. Identification of different non-insect pests viz., birds, crabs, snails and slugs.
16. Identification of different household and veterinary insect pests

Suggested readings

1. Atwal, A.S. and Bains, S.S. 1989. Applied Animal Ecology. Kalyani Publishers, New Delhi
2. Dhaliwal, G.S. and Ramesh Arora 2016. Integrated Pest Management: Concepts and Approaches, Third Edition, Kalyani Publishers, Ludhiana
3. Eugene P. Odum and Gray W Barrett. 2020 Fundamentals of Ecology. Fifth Edition. Cengage India Private Limited. New Delhi.
4. Gautam, R.D. 2008. Biological Pest Suppression. Westville Publishing House, New Delhi
5. Ishaaya, I. And Degheele, D. 2013 Insecticides with Novel Modes of Action, Mechanisms and Application. Springer Berlin Heidelberg.
6. Larry P Pedigo, and Marlin E Rice. 2009. Entomology and Pest Management. Prentice Hall of India Private Ltd., New Delhi
7. Metcalf, R. L. and Luckman, W. H . 1994 Introduction to Insect Pest Management. Third Edition, Wiley India Pvt. Ltd. Noida
8. Vasantharaj David, B. And Aanathakrishnan, T. N. 2006. General and Applied Entomology. Tata McGraw-Hill Publishing House, New Delhi.
9. Vasantharaj David, B. And Ramamurthy V.V. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New Delhi.
10. Yazdani, S.S. and Agarwal, M. L. 1979. Elements of Insect Ecology. Narosa Publishing House, New Delhi.

ENTO 331
INSECT PEST MANAGEMENT IN FIELD CROPS
2 (1+1)

Objectives

1. Diagnosis and management of major insect and non- insect pests of field crops.
2. Structural Entomology and house hold pest management

Course outlines

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 field crops. Scientific name, order, family, host range, distribution, nature of damage and control practices for other important arthropod pests of various field crops. Management of non-insect pests, mites, snails and slugs, birds, nematodes, vertebrates and rodent pests of field crops. Locust management. Structural Entomology and important household pests, their nature of damage and management.

Practical

Field visit, Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking different field crops. Identification of mites, birds, rodent and vertebrate pests of field crops. Calculations of the doses of insecticides. Spraying techniques for selected field crops Study on structural entomology and household pests.Vertebrate pest management.

Lecture Outlines

Theory

1. Introduction of Economic Entomology and Economic Classification of Insect Pests
2. Rice: Yellow stem borer and other borers, gall midge, brown plant-hopper, Thrips, reen leafhopper, hispa, leaf folder, ear head bug, grasshoppers, root weevil, swarming caterpillar, paddy skipper, climbing cutworm, case worm, whorl maggot, leaf mite and panicle mite- IPM practices.
3. Sorghum, Maize and other millet crops: Sorghum shoot fly, stem borer, pink borer, sorghum midge, ear head bug, red hairy caterpillar, fall army worm, Deccan wingless grasshopper, aphids, maize shoot bug, flea beetle, blister beetles,
4. Ragi: Ragi pink borer, Ragi cutworm and ragi root aphid - IPM practices. Wheat: Ghujia weevil, ragi pink borer and termites- IPM practices.
5. Sugarcane: Early shoot borer, internode borer, top shoot borer, scales, leafhoppers, white grub, mealybugs, termites, whiteflies, woolly aphid and yellow mite-IPM Practices.
6. Cotton: Spotted bollworm, American bollworm, pink bollworm, tobacco caterpillar, leafhopper, whiteflies, aphids, mites, thrips, red cotton bug, dusky cotton bug, leaf roller, stem weevil, grasshoppers and mealybug - IPM Practices.
7. Jute: Semilooper, stem weevil, stem girdler and Bihar hairy caterpillar. Mesta: Hairy caterpillars, stem weevil, mealybugs, leafhopper and aphid. Sun-hemp: Hairy caterpillars, stem borer and flea beetle. IPM Practices.
8. Pulses: Gram caterpillar, plume moth, pod fly, stem fly, spotted pod borer, IPM of gram caterpillar and spotted pod borer.
9. Pulses: Cowpea aphid, Thrips, cowbug, pod bug, leafhopper, stink bug, green pod boring caterpillar, blue butterflies, leaf webber/borer and redgram mite. Soybean: Stem fly, stem girdler, ragi cutworm, leaf miner and whitefly- IPM Practices.Pea: pea leaf miner and pea stem fly,
10. Groundnut: White grub, leaf miner, red hairy caterpillar, tobacco caterpillar, leafhoppers, thrips, aphid, leaf bud borer, pod bug, wire worm, earwig, jewel beetle and mites - IPM Practices.
11. Castor: Semilooper, shoot and capsule borer, tobacco caterpillar, leafhopper, butterfly, whitefly, thrips, castor slug and mite - IPM
12. Sesame: Leaf webber and pod borer, gall fly and sphinx caterpillar Safflower: Aphids and leaf eating caterpillars- IPM Practices Mustard: Aphid, sawfly, diamond back moth and painted bug. Sunflower: Helicoverpa and Spodoptera, leafhopper, Bihar hairy caterpillar and thrips - IPM Practices.
13. Locusts: Locusts and their management Mites: Economically important phytophagous mites of field crops andtheir management Nematodes: white tip nematode of Rice, cyst and gall nematode of wheat, root knot nematode and their management.
14. Rodents: Rodents damaging field crops and their management. Birds: Various birds infesting field crops and their management
15. Structural Entomology and important household pests, their nature of damage and

management. Termites, cockroach, bed bugs, mosquitoes and flies. Precautions in household pest management.

16. Use of Drones and AI in Pest management of field crops (as separte lecture by merging Rice)

Practicals

1. Typical symptoms of damage by various phytophagous insects.
2. Spraying techniques in field crops
3. Calculation of the doses of insecticides.
4. Identification of major insect pests of rice and their damage symptoms
5. Identification of major insect and mite pests of sorghum, maize and other millet crops, and their damage symptoms.
6. Identification of insect pests of sugarcane and their damage symptoms
7. Identification of insect pests of cotton and their damage symptoms
8. Identification of insect pests of minor fibre crops, sunnhemp, jute and mesta and their damage symptoms
9. Identification of insect pests of pulse crops and their damage symptoms.
10. Identification of insect pests of other oil seed crops: sunflower, safflower, sesame, mustard and castor and their damage symptoms.
11. Mite and Nematode pests of various crops and their damage symptoms.
12. Bird and Rodent pests of various crops and their damage symptoms.
13. Major vertebrate pests and their damage symptoms.
14. Structural Entomology and Household Pest Management (Termite control) (Cockroach, Bed bugs, flies and mosquitoes)
15. Mass multiplication of NPV and entomopathogenic nematodes
16. Use of Drones in Pest management in Field crops

Suggested readings

1. Vasantharaj David, B. and Ramamurthy V.V. 2016. Elements of Economic Entomology, Popular Book Depot, Coimbatore.
2. Vasantharaj David, B and Aanathakrishnan, T.N. 2006. General and Applied Entomology. Tata McGraw- Hill Publishing House, New Delhi.
3. Nair MRGK. 1986. Insects and Mites of Crops in India. Indian Council of Agricultural Research New Delhi.
4. Ramakrishna Ayyar, T.V. 1963. Handbook of Economic Entomology for South India. Government Press, Madras.
5. Dennis S Hill 1987 Agricultural Insect Pests of Tropics and their Control, Cambridge University Press , New York
6. Athwal, A.S. 1976. Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
7. Srivastava K.P and Dhaliwal., G. S 2010. A Textbook of Applied Entomology, Kalyani Publishers, New Delhi.
8. Prakash Rambhat Thalya and Ravi Chandra 2022 Essentials of Pest Management: Key Information on Pest Identification and its Management. Wings Publications International, Maharashtra

ENTO 332
INSECT PEST MANAGEMENT IN HORTICULTURAL CROPS AND STORED GRAINS
2 (1+1)

Objectives

1. Diagnosis and management of major insect pests and non- insect pests of Horticulture crops
2. Identification and management of insect pests and non-insect pests of stored grains

Course outlines

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 Vegetable crops, fruit crops, plantation crops, ornamental crops, spices and condiments. Management of non-insect pests, mites, snails and slugs, birds, nematodes, vertebrates and rodent pests of horticultural crops. Factors affecting loss of stored grains. Insect pests, mites, rodents, birds and associated with stored grains and their management.

Practical

Field visit, Identification of different types of damage symptoms of various horticultural crops. Identification and study of life cycle and seasonal history of various insect pests attacking different Horticultural crops. Identification of mites, birds, rodent and vertebrate pests of Horticultural crops. Stored grain Pests- Factors affecting losses of stored grain, Storage structures and Methods of grain storage.

Lecture Outlines

Theory

1. Brinjal: Epilachna beetle, shoot and fruit borer, stem borer, mealybug, leafhopper, lacewing bug, leaf webber and red spider mite- IPM practices.
2. Bhendi: Shoot and fruit borer, leafhopper, whitefly and spider mite; Tomato: Serpentine leaf miner, South American leaf miner/ Tomato pin worm, fruit borer, thrips and whitefly - IPM practices.
3. Cucurbits: Fruit flies, pumpkin beetles, semilooper, serpentine leaf miner and pumpkin leaf eating caterpillar; Coccinia: Coccinia gall fly and aphids - IPM practices.Crucifers: Diamond back moth, cabbage head borer, leaf webber, aphid, painted bug, tobacco caterpillar and cabbage butterfly - IPM practices.
4. Potato: Tuber moth; Sweet potato: Sweet potato weevil, hairy caterpillar, tortoise beetle; Chillies: Thrips, Black Thrips,whitefly, pod borers, aphid, blossom midge, mites; Moringa: Hairy caterpillar, budworm, leaf webber and pod fly; Amaranthus: Leaf eating caterpillar, stem weevil - IPM practices.
5. Mango: Leafhoppers, stem borer, nut weevil, fruit fly, shoot borer, fruit borer, semilooper(Perixera sp.), mealybug, aphids, leaf webber, termites, thrips, red tree ant, leaf gall midges and red spider mite - IPM practices.
6. Citrus: Butterfly, fruit sucking moths, leaf miner, psylla, rust mite, bark eating caterpillar, black fly and leaf mite - IPM practices. Grapevine: Flea beetle, thrips, mealybug, stem girdler, stem borer, leaf eating caterpillars and root grub - IPM practices.
7. Cashew: Tree borer, shoot and blossom webber, tea mosquito bug, thrips and leaf miner; Pomegranate: Butterfly, thrips and fruit sucking moths - IPM practices.
8. Guava: Tea mosquito bug, mealybug, fruit flies and spiralling whitefly; Sapota: Leaf

webber, parijatha hairy caterpillar, mealybugs; Ber: Fruit fly, fruit borer and fruit weevil - IPM practices. Banana: Rhizome weevil, skipper, aphid and pseudostem weevil; Papaya: Whiteflies, mealybugs and thrips; Apple: Woolly aphid and Codling moth; Custard apple: Mealybug - IPM practices.

9. Coconut: Black headed caterpillar, rhinoceros beetle, red palm weevil, slug caterpillar, rugose spiralling whitefly, scale, termites, and mite; Oil palm: Black headed caterpillar, rhinoceros beetle and red palm weevil - IPM practices.
10. Arecanut: Scales; Cocoa: Scales; Cardamom: Thrips; Pepper: Pollu beetle and shoot borer; Coriander: Aphids and leaf eating caterpillar; Turmeric and ginger: Rhizome fly and Lacewing bug; Betel vine: Shoot bug and tobacco caterpillar; Onion: Thrips and Beet army worm; Eucalyptus: Gall wasp; Neem: Tea mosquito bug and white grub - IPM practices.
11. Rose: Thrips, scales, leaf eating caterpillars and chafer beetles; Jasmine: Stink bug, bud worm and gall mite; Chrysanthemum: Aphid - IPM practices; Tobacco: Tobacco caterpillar, aphid, whitefly and stem borer; Coffee: White borer, red borer, Coffee berry borer, Shot hole borer and green scale; Tea: Tea mosquito bug, thrips, red spider mite, pink mite, purple mite and scarlet mite- IPM practices.
12. Non-insect Pest management in horticultural crops - Mites, nematodes, Snails, slugs and others
13. Vertebrate Pest management in horticultural crops - Rodents, Birds, Wild boars, Monkeys and other wild animals
14. Stored grain Insect pests - Rice weevil, lesser grain borer, khapra beetle, pulse beetle, groundnut bruchid, flour beetles, saw-toothed beetle, Flat grain beetle, cigarette beetle, Angoumois grain moth, Meal moth rice moth and non-insect pests of stored grain (Psocids, grain mites,birds and rodents).
15. Stored grain Pests- Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain.
16. Storage structures, fundamental principles, methods of grain storage and Systems approachin stored grain pest management (Prophylactic and curative measures).

Praticals

1. Identification of insect pests of Brinjal, Bhendi and Tomato and their damage symptoms.
2. Identification of insect pests of Cruciferous and Cucurbitaceous vegetables and their damage symptoms.
3. Identification of insect pests of potato, sweet potato, moringa, Amaranthus and chilli and their damage symptoms.
4. Field visit to different vegetable crops and collection of damage symptoms
5. Identification of insect pests of mango, cashew and their damage symptoms.
6. Identification of insect pests of citrus, banana, grapevine, pomegranate and sapota and their damage symptoms.
7. Identification of insect pests of papaya, apple, custard apple, ber and guava and their damage symptoms.
8. Field visit to different Fruit orchards and collection of damage symptoms
9. Identification of insect pests of coconut and oil palm and their damage symptoms.
10. Identification of insect pests of arecanut, cocoa, cardamom, pepper, eucalyptus and neem and their damage symptoms.
11. Identification of insect pests of spices, narcotics (turmeric, betel vine, onion, tobac-

co & ginger), pests of ornamental plants and their damage symptoms
12. Field visit to different horticultural and flower gardens and collection of damage symptoms
13. Identification of insect and non-insect pests (Psocids,grain mites, birds and rodents) of stored grain
14. Methods of grain sampling and Determination of grain moisture content
15. Methods of detection of infestation by stored grains insect pests and assessment of losses in stored grain due to insect pests
16. Visit to nearest FCI/CWC/SWC godowns and demonstration of fumigation methods

Suggested Readings

1. Vasantharaj David, B. and Rama Murthy V.V. 2016. Elements of Economic Entomology, Popular Book Depot, Coimbatore.
2. Vasantharaj David, B and Aanathakrishnan, T.N. 2006. General and Applied Entomology. Tata McGraw- Hill Publishing House, New Delhi.
3. Nair MRGK. 1986. Insects and Mites of crops in India. Indian Council of Agricultural Research New Delhi.
4. Ramakrishna Ayyar, T.V. 1963. Handbook of Economic Entomology for South India. Government Press, Madras.
5. Dennis S Hill 1987 Agricultural Insect Pests of tropics and their control, Cambridge Universtiy Press , New York
6. Atwal, A.S. 1976. Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
7. Srivastava K.P and Dhaliwal., G. S 2010. A Textbook of Applied Entomology, Kalyani Publishers, New Delhi.
8. Prakash Rambhat Thalya and Ravi Chandra 2022 Essentials of Pest Management: Key Information on Pest Identification and its Management. Wings Publications International, Maharastra
9. Khare, S.P. 1993.Stored grain pests and their management. Kalyani Publishers, Ludhiana
10. Mandali Rajasri, Alice R.P.Sujeetha, Chandra Sekhar Gupta and P. Geetha 2019. Hand book on Stored grain pests and their identification. National Institute of Plant Health Management, Hyderabad

SEC I
BIOFERTILIZERS AND PLANT BASED BIOPESTICIDE PRODUCTION
2 (0+2)

Objectives

1. To understand the types and importance of bio-fertilizers, techniques for isolating microbial strains used in biofertilizers, hands-on experience in preparing specific culture media for biofertilizer organisms.
2. To impart skill on the quality and efficiency of biofertilizers, preparation of carrier materials for biofertilizer inoculants, application methods and field usage of biofertilizers.
3. To understand the types and importance of plant basedbio-pesticides and to impart knowledge and skill in preparation and usage

Course outlines

Practical

Importance of biofertilizers. Isolation, characterization and mass multiplication - Rhizobium, Azotobacter, Azospirillum, Phosphorus and Potassium solubilizing bacteria, VAM fungi. Production of Azolla, Cyanobacteria. Quality control and application methods, registration procedures.

To study the plant based biopesticides used in Insect and Non-Insect Pest Management. Preparations and extractions – Neem Seed Kernel Extract, Neem leaf extract, Neem cake extract and Neem oil, neem based formulations and their uses. Plant extracts- Tobacco, Annona, Lantana, Pongamia, Garlic, Chillies and their uses. Essential oils - extraction. Insecticidal properties-Derris, Acorus, Plumbago and Sabadilla.

Practicals

1. PATH - Introduction and importance of Biofertilizers
2. PATH - Preparation of Culture Media for isolation of biofertilizers
3. PATH - Isolation and characterization of Rhizobium from root samples
4. PATH - Isolation and characterization of Azotobacter from soil samples
5. PATH - Isolation and characterization of Azospirillum from soil samples
6. PATH - Isolation and characterization of Phosphorous Solubilizing Bacteria (PSB) from soil samples
7. PATH - Isolation and characterization of Potassium Solubilizing Bacteria (KSB) from soil
8. PATH - Isolation and characterization of Vesicular Arbuscular Mycorrhizae (VAM) from soil and root samples
9. PATH - Mass production of Azospirillum and Azotobacter
10. PATH - Mass production of Rhizobium and PSB
11. PATH - Mass production of KSB and VAM
12. PATH/SSAC - Azolla and Cyano bacteria production and field application methods
13. PATH - Quality Control of Biofertilizers - CFU, moisture content and pH
14. PATH - Carriers used for formulating biofertilizers (Solid and liquid)
15. PATH/SSAC - Application methods of biofertilizers - seed treatment, seed pelleting, soil application and foliar spray techniques.
16. SSAC - Field demonstration of biofertilizer application in various crops (Legumes, cereals).
17. PATH - Biofertilizer consortia - Preparation and Compatibility testing
18. PATH - Assessment of the efficacy of biofertilizers - Nitrogen Fixation Activity Assays - Acetylene reduction assay (ARA), Nodulation efficiency
19. PATH - Acquaintance with botanicals used in plant disease management
20. ENTO - Preparation of Neemastram and Panchapatra kashayam
21. Acquaintance of plant based biopesticides used in insect pest management, bioactive principles, mode of action, advantages and disadvantages
22. ENTO - Preparation of Neem Seed Kernel Extract (NSKE) and Neem leaf extract and their uses
23. ENTO - Preparation of Neem cake extract, Neem oil emulsion and their uses and study of neem based formulations available in market
24. ENTO - Preparation of Tobacco decoction and its uses
25. ENTO - Preparation of Annona leaf extracts and Lantana leaf extracts
26. ENTO - Preparation of Pongamia kernel extract

27. ENTO - Preparation of Garlic and Chilli extracts
28. ENTO - Extraction of Essential oils of Lemon grass
29. ENTO - Insecticidal properties of Derris, Acorus, Plumbago and Sabadilla
30. ENTO - Plant based biopesticides for non-insect pest management
31. PATH - Procedure for registration and licencing of biofertilizers and plant based biopesticides
32. PATH/SSAC - Visit to biofertilizer mass production centres

Suggested readings

1. Anand Prakash and Jagadiswari Rao 1997. Botanical Pesticides in Agriculture. CRC Press Inc, New Delhi.
2. Dodia D. A., Rabari, P.H., Zala, M. B and Patel, G.M (Second edition).2021. Botanical pesticides for Pest management. Scientific Publishers, Jodhpur.
3. Kannaiyan, S., Kumar, K, Govindarajan, K. 2013. Biofertilizers technology. Scientific Publishers, Jodhpur.
4. Parmar, B. S and Deva Kumar C.1993. Botanical and Biopesticides. West Will Publishing House, New Delhi pp 199.
5. Rangaswami, G and Bagyaraj, D.J. 2023. Agriculture Microbiology. PHI Learning and Private Limited.
6. Robert L. Tate.III.1999. Soil Microbiology. Wiley India Private Limited.
7. Somani, L.L, Bhandari, S.C, Saxena, S.N. and Vyas, K.K. 1990. Biofertilizer. Scientific Publisher, Jodhpur.
8. Srivastava, K. P. and Dhaliwal, G.S 2015. Applied Entomology. Vol I &II , Kalyani Publishers, New Delhi.
9. Subbarao, N.S. 1993. Biofertilizers in Agriculture and forestry (Third Edition). Oxford & IBH Publishing Co. Pvt. Limited, New Delhi.
10. Subbarao, N.S. 2024. Soil Microbiology (Fourth Edition). Oxford & IBH Publishing Co. Pvt. Limited, New Delhi.

SEC VII
BENEFICIAL INSECT FARMING
2 (0+2)

Objective

1. To study the beneficial insects with respect to their commercial use in Agriculture

Course outlines

Practical

Importance of beneficial insects-Honey bee species-Biology and caste determination, bee hive boxes and other equipment. Bee pasturage, seasonal management, bee hive products, extraction and processing of honey and other bee hive products. Bee enemies and diseases and their management. Bee pollination. Lac insects- species of lac insect and their host plants. Brood lac inoculation and crop harvesting. Raw lac, seed lac and shellac and various applications of lac. Enemies of lac insect and management. Insects as waste decomposers. Black soldier fly- Biology and mass rearing techniques. Black soldier fly as feed. Species of silkworm and their host plants. Raising of mulberry garden, pests, diseases and nutritional deficiencies of mulberry. Silkworm rearing-house and equipment, chawki rearing, late age rearing, bed cleaning and mountages. Pests and diseases of silkworm. Silkworm cocoons. Mass multiplication of parasitoid Trichogram-

ma and predator Cryptolaemus.

Practical

1. Introduction and importance of beneficial insects
2. Identification of honeybee species and bee hive products and their importance
3. Biology and caste determination in honey bees
4. Beehive boxes and other equipment
5. Identification of nectar and pollen yielding plants (Bee pasturage)
6. Seasonal management of honey bee colonies
7. Inspection of bee colonies including division and uniting of honeybee colonies
8. Insect and mite pests & diseases of honey bees and their management and measures to prevent pesticide poisoning to honeybees
9. Extraction/collection and processing of honey and other beehive products
10. Bee pollination in crops (Honeybees and Bumble bees)
11. Visit to commercial apiary / honey processing unit
12. Identification and study of lac insect strains and species and their host plants
13. Brood lac inoculation on host plants, forecast of larval emergence and crop harvesting
14. Lac cultivation on bushy host Flemingia semialata
15. Processing of lac- raw lac, seed lac and shellac and applications of lac
16. Enemies of lac insects and their management
17. Insects as waste decomposers- Scavengers - Black soldier flies, mealworms, dung rollers, flesh flies, and carrion flies
18. Biology and identification of different stages of black soldier fly and its mass rearing techniques
19. Black soldier fly farming- Importance as waste decomposer and as poultry/fish feed
20. Composting with black soldier flies
21. Species of silkworms and their host plants
22. Preparation of planting material and raising of mulberry garden
23. Important insect pests, diseases and nutritional deficiencies of mulberry and their management
24. Silkworm rearing house and rearing equipment
25. Chawki rearing of silkworm larvae
26. Rearing of late age silkworm larvae and bed cleaning
27. Important pests and diseases of mulberry silkworm and their management
28. Mounting of late age silkworm larvae and types of mountages
29. Harvesting of silkworm cocoons, stifling, grading and identification of defective cocoons.
30. Visit to commercial sericulture unit/ Grainage /Silk cocoon market
31. Mass multiplication of Corcyra cephalonica, egg parasitoid - Trichogramma sp. and production of tricho cards.
32. Mass multiplication of important predators - Cryptolaemus montrouzieri

Suggested readings

1. Abrol, D. B. 2019 Beekeeping : A Compressive Guide To Bees And Beekeeping. Scientific Publishers, Jodhpur
2. Bram Dortmans, Stefan Diener, Julia Egger and Christian Zurbrügg 2021 Black Sol-

dier Fly Biowaste Processing - A Step-by-Step Guide, 2nd Edition. Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland.
3. David Cramp 2008 A Practical Manual Of Beekeeping: How to Keep Bees and Develop Your Full Potential as an Apiarist. Spring Hill Publishers, Taiwan.
4. Ganga, G And Sulochana Chetty 2020 An Introduction to Sericulture. 2nd Ed. Oxford & IBH Publishing, New Delhi.
5. Koteswara Rao, S. R. Mayank Kumar Rai, Singh, R.P. and Nagaraja, N. 2016 Beekeeping - Theory and Practical. National Institute of Open Schooling, Noida, U.P.
6. Kumar, K.K, Ramani, R. and Sharma, K. K. 2002 Recent Advances in Lac culture. Indian lac Research Institute, Ranchi.
7. Sharma K.K, Monobrullah Md, Mohanasundaram A and Ramani R. 2016. Beneficial Insect Farming - Benefits and Livelihood Generation. ICAR- Indian Institute of Natural Resins & Gums, Ranchi (Jharkhand), India.
8. Vasantharaj David, B. and Rama Murthy V.V. 2016. Elements of Economic Entomology. Brillion Publishing, New Delhi.

SEC XVI
COMMERCIAL SERICULTURE
2 (0+2)

Objective

1. To develop skill in Rearing of Silkworms commercially

Practicals

Importance of Sericulture: Species of silkworm and their host plants. Raising of mulberry garden, pests, diseases and nutritional deficiencies of mulberry. Silkworm rearing-house and equipment, chawki rearing, late age rearing, bed cleaning and mountages. Pests and diseases of silkworm. Silkworm cocoons. Reeling of Silk, visit to silk reeling units

Lecture Outlines

Practicals

1	Acquaintance with silk producing insects and sericulture
2	Silkworm species and bioecology
3&4	Mulberry silkworm - systematic position, distribution, detailedmorphology and biology
5	Voltinism and Development of new hybrid silkworm races
6	MoricultureMaintenance of mulberry garden- Agronomical practices
7	Mulberry varieties and their characteristics
8	Preparation and plating of mulberry garden
9	Planting systems of mulberry garden
10	Pruning of mulberry garden and leaf harvest
11	Management of important pests of mulberry
12	Management of important diseases of mulberry
13	Visit to government and private managed mulberry garden within the District
14	Acquaintance with different appliances of silkworm rearing
15	Model rearing house and methods of disinfection of sericulture unit
16	Visit to nearby Grainages
17	Chawki rearing of mulberry silkworm

18 Handling of silkworm during moult and other methods of chawki rearing
19 Visit to nearby chawki centres
20 Rearing of late age / old age silkworm larvae
21 Dissection of silkworm larval salivary glands
22 Different methods of rearing late age silkworms
23 Different types of mountages
24 Visit to silkworm rearing centre of farmers
25 Harvesting of cocoons and cocoon characters Types of defective cocoons and their management
26 Reeling of Silk from the cocoons- Visit to silk reeling units
27 Pests of mulberry silkworm and their management
28 Diseases of mulberry silkworm and their management
29&30 Visit to nearby cocoon selling units (Govt. and Private) and Interaction of silk worm rearing farmers with students and their feedback
31 Acquaintance with rearing of eri silkworm on castor
32 Economic analysis of silkworm rearing

ELCT 431
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.

Course Outlines

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

Lecture Outlines

Theory

1. ENTO - Introduction and history of biological control of pests and diseases, History and development of bio formulations and nano formulations
2. ENTO - Microbial biopesticides (Fungi, bacteria, actinomycetes, virus, bacteriophage and nematodes) v/s biorational pesticides and biostimulants, chitosan.
3. PATH - The global and Indian market scenario of biopesticides: Global and Indian Scenario. No of biopesticides countrywise, bacterial and other microbial based bioformulations
4. ENTO - Biopesticides for organic agriculture: Harmful effects of chemo-intensive agriculture, Harmful effects of chemo intensive agriculture, Importance, scope and potential of biopesticides and benefits of biopesticides
5. SSAC - Organic farming principles and production practices: Implications of bio formulations and nano formulations in organic farming
6. SSAC - Organic farming certification and organizations involved
7. PATH - Phytopathogenic biocontrol agents: Classification and Mode of action (Trichoderma sp. And Pseudomonas SP)
8. ENTO - Entomopathogenic biocontrol agents: Classification and Mode of action of Entomo Pathogenic Fungi (EPFs)
9. ENTO - Production protocols for *Beauveria bassiana, Metarhizium anisopliae, Lecanicillium lecani*
10. ENTO - Classification and Mode of action of Entomopathogenic Bacteria, *Bacillus thuringiensis (Bt)*
11. ENTO - Biology and Applications of *Bacillus thuringiensis (Bt) formulations and Bt PIPS (Plant Incorporated Protectants)*
12. ENTO - Production protocols for Bt toxins; Classification of bt toxins, deltaendotoxin production protocols
13. ENTO - Mode of action of Entomo Pathogenic Virus (EPVs): NPV, GV, CPV's
14. ENTO - Production protocols for NPV and GV
15. ENTO - Mode of action of Entomo Pathogenic Nematodes (EPNs) *Steinernema carpocapsae, Heterorhabditis sp*
16. ENTO - Production protocols for EPNs: in vivo mass multiplication and in vitro: Solid, liquid media cultures
17. ENTO - Production and quality assessment of biopesticides (Pesticide Testing Laboratories)
18. SSAC - Microbial inoculants as biofertilizer candidates (Azolla, Azotobacter, PSB)
19. PATH - Plant Growth Promoting Microorganism for Managing Plant Diseases and

Improving Soil Quality: Mycorrhiza, VAM fungi, Mycorrhiza associated Bacteria (MAB)

20. PATH - Plant Growth Promoting Microorganisms (PGPM) and Plant Growth Promoting Rhizobacteria (PGPR)
21. PATH - PGPR for phytohormone and siderophore production; enzymes (chitinase, lignocellulose decomposing enzymes) and HCN and ammonia production
22. PATH - Management of virus vectors with PGPM metabolites (Foul odours and metabolites from fungal and bacterial PGPMs prevent virus vector colonization)
23. SSAC - Production and quality assessment of biofertilizers: FCO specifications and quality control of biofertilizers, Storage, shelf life, Plant infection test and marketing of Biofertilizers, Factors influencing the efficacy of biofertilizers
24. SSAC - Methods of application of biopesticides and biofertilizers - Seed treatment, seed biopriming, seedling dip, foliar application and soil application etc.,
25. SSAC - Soil inoculation and Seed treatment & Order of seed treatment with fertilizers and biopesticides (FIR)
26. PATH - Adjuvants for increasing the efficiency of biopesticides (Surfactants, transporters, protective agents, nutritional adjuvants)
27. PATH - Novel tensio-active microbial compounds for biological control (Rhamnolipids)
28. PATH - Formulations of botanicals and plant essential oils
29. ENTO - Pheromones and formulations of and Parapheromones and their application in insect pest management
30. ENTO - Specialized Pheromone & Lure Application Technology (SPLAT), Formulation, application techniques, advantages over conventional lures
31. ENTO - Use of parasitoids for insect pest management: *Trichogramma, Bracon sp, Goniozus sp, Chelonus, Tetrastichusetc.,*
32. ENTO - Use of predators for insect pest management: *Chrysoperla zastrowi sillemi , Cryptolaemus montrouzieri,*
33. ENTO - Regulatory system of biopesticides in India (CIBRC & Accredited laboratories)
34. SSAC - Nanotechnology- Introduction, History, definition and concepts
35. SSAC - Nano mission projects at the national level: Nano Mission (Nano Science and Technology Mission - NSTM), Nanotechnology initiative, GOI
36. SSAC - Classification of Nanomaterials- based on dimension and origin; 1) Inorganic-based, solid, and non-biodegradable nanoparticles (gold, silver, copper, iron, aluminium oxide, zinc oxide, titanium dioxide, cadmium sulphide and silica-based nanoparticles),
37. SSAC - Classification of Nanomaterials 2) organic-based biodegradable nanoparticles (liposomes, solid lipid, and polymeric nanoparticles) and 3) hybrid nanoparticles (combination of both inorganic and organic components)
38. SSAC - Engineered nanoparticles (metals and metaloxides): Engineered Metal Oxide Nanoparticles as Fungicides for Plant Disease Control- Antifungal Properties of Mono-Metal Oxide Nanoparticles - Zinc oxide nanoparticles (ZnO-NPs), Copper oxide nanoparticles (CuO-NPs), Magnesium oxide nanoparticles (MgO-NPs), etc.,
39. SSAC - Nanotechnology applications in Agriculture, merits and demerits of nanotechnology. Non-target effects, Safety issues of bio formulations and nano formulations

40. SSAC - Nano biopesticides: Concept and importance, Types of polymer nanoparticle formulations for delivery of pesticides (Nanocapsules, nanoparticles, nanogels, nanoemulsions, nanosuspensions, nanospheres, micelles, dendrimers)
41. ENTO - Mode of action of Nanopesticides for the management of mosquitoes, caterpillars and stored grain pests
42. SSAC - Techniques for the production of nano biopesticides: Top down and bottom up appraoches
43. SSAC - Nano Fertilizers: Concept and importance, Nanofertilizer types: Action based, Nutrient based and consistency based
44. SSAC - Types of nano fertilizers (Nano Urea, Nano DAP)
45. SSAC - Techniques for the production of nano fertilizers
46. SSAC - Green synthesis of nano fertilizers and pesticides (from leaves of *Azadirachta indica, Acalypha indica, Phyllanthus amarus, Calotropis gigantea and bark extract of Terminalia Arjuna)*
47. SSAC - Slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles
48. ENTO - Nano pheromone production and field application

Practicals

1. ENTO - Introduction and acquaintance with biopesticide laboratory
2. PATH - Preparation of culture media
3. PATH - Isolation and purification of bioagent from soil and infected insects
4. PATH - Microscopic study of different microbial bioagents
5. PATH - In vitro assay of microbial bioagents against plant pathogensIn vitro compatibility study mong different microbial bioagents
6. ENTO - Mass multiplication of biopesticides
7. PATH - Population enumeration of biocontrol agents in different biopesticides
8. ENTO - Preparation of plant extracts and their efficacy test against insect pests
9. ENTO - Use of pheromone and parapheromone. Monitoring and management of insect pests
10. ENTO - Bioassay of Entomopathogenic biocontrol agents on insect pests
11. PATH - Preparation of microbial inoculants, biofertilizers and plant growth stimulating microbes
12. ENTO - Compatibility of bioformulations of biofertilizers and biopesticides
13. PATH - Preparation of solid and liquid consortia of biofertilizer microbes
14. SSAC - Formulation and Characterization of nano materials
15. SSAC - Synthesis of nanopesticides and nano fertilizers
16. SSAC - Applications of nanoparticles in Agriculture

Suggested Readings

1. Baker, E. F and James, R. C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society, St. Paul, Minnesota, USA.
2. Borkar, S. G. 2015. Microbes as Bio-Fertilizers and their Production Technology. Woodhead Publishing India, New Delhi, India.
3. Boland, G. J and Kuykendall, L.D. 1998. Plant microbe interactions and Biological Control. Basel Marcel Dekker, Inc. Switzerland.
4. Ciancia, A and Mukerji, K. J. 2007. General Concepts of Integrated Pest and Disease Management. Springer, Dordrecht, The Netherlands.
5. Cincholkar, S. B and Mukherji, K. G. 2007. Biological Control of Plant Diseases.

Hawarth Food and Agricultural products, Haworth Food & Agricultural Products Press, New York, USA.
6. Gnanamanickam, S. S. 2002. Biological Control of Crop Diseases. Marcel Dekker, New York, USA.
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 Diseases, Phytoparasitic Nematodes and Weeds. Precision Fototype Services, Bengaluru.
9. Allhoff, F and Lin, P (Eds). 2009. Nanotechnology and Society- Current and Emerging Ethical Issues. Springer, UK.
10. Prasad, R., Kumar, V., Kumar, M and Choudhary, D (Eds). 2019. Nanobiotechnology in Bioformulations (Nanotechnology in the Life Sciences). Springer, UK.
11. Koul, O (Ed). 2019. Nano-biopesticides Today and Future Perspectives. Academic Press.
12. Shah, M. A and Ahmad, T. Nano Science and Technology. Wiley India. Websites : https:// apbb.fftc.org.tw/article/413
13. Parmar, B.S.V Devakumar, V, 1994(EDS). Botanical and Biopesticides. Westvill Publishing House, New Delhi pp.199

AGRICULTURAL ECONOMICS

AECO 241
PRINCIPLES OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT
3 (2+1)

Objective

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

Course Outlines

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 andservices, 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, equimarginal 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 programmes 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.

Lecture Outlines

Theory

1	Introduction to Economics - Definitions, Meaning, Scope; Economic activity - Households, Firms and Govt. sector
2	Subject matter of economics: Traditional approach- Production, Consumption, Distribution and Exchange; Modern approach - Micro economics and Macro economics.
3	Methods of economic investigation - Deduction and Inductive approaches; Positive and Normative analysis; Agricultural Economics - Meaning and Definition
4	Basic concepts - Goods and Services - Characteristics and Classification;

Human wants - Characteristics and Classification

5 Utility - Forms of utility; Concepts - cost, price, value, wealth, welfare, capital, income, investment, efficiency, firm and industry.

6 Theory of Consumer Behaviour - Cardinal and Ordinal approaches - Assump tions of consumer behaviour - Marginal utility, Total utility - Law of Diminish ing Marginal Utility - Meaning, assumptions, explanation, application and exceptions

7 Law of Equi Marginal Utility and Consumer's Surplus - Meaning, assumptions, explanation, application and exceptions

8 Indifference curve analysis - Indifference curves - Meaning, basic assump tions, properties and importance - Budget line and its properties - Consumers equilibrium.

9 Demand - meaning, demand function, law of demand, demand schedule, char acteristics of demand curve, determinants of demand, derivation of demand curve, changes in demand

10 Elasticity of demand - types and degrees of elasticity of demand - factors af fecting elasticity of demand - practical importance of elasticity of demand

11 Supply - Stock and Supply, law of supply, supply schedule, characteristics of supply curve, determinants of supply, elasticity of supply

12 Price determination under perfect competition - Perishable and Durable com modities; Equilibrium analysis - Numerical and graphical explanation

13&14 Distribution theory: meaning, factor market - pricing of factors of production; Rent - Ricardian theory & Modern theory; Wage - Kinds of wages and modern theory of wages; Backward bending supply curve of labour; Interest and Profit meaning

15 National income: meaning, importance, circular flow - Three sector economy

16 Concepts of national income accounting - Approaches to and difficulties in measurement of National Income.

17 Population - Importance, Malthusian theory and optimum population theory - Natural and socio- economic determinants

18 Money - Barter system of exchange and its problems - Classification of money, Functions of money; Money market - Demand for money and supply of money in the economy

19 Meaning of Inflation, deflation, Disinflation, Reflation & stagflation; Types of in flation - Creeping, Walking, Running, Galloping, Suppressed, Comprehensive, Sporadic, Mark-up, Demand-pull, Cost- push inflation

20 Measurement of inflation - General price index, Rate of inflation, Consumer price index, Wholesale price index - Control measures of inflation

21 Economic system - concepts and functions of economy; Types and Features of economic systems - Capitalism, Socialism and Mixed economy

22 Elements of Economic planning - Five year plans - Meaning and objectives; NITI Ayog - Genesis and its objectives

23 Farm Management - Definition and Objectives; Farm Management vs Produc tion Economics

24 Production - Meaning and Factors of production; Production function - Mean ing; Laws of returns - Increasing returns, Decreasing returns and Constant returns

25 Factor - Product relationship - Three stages of production function
26 Factor - Factor relationship; Isoquant - Properties, Marginal rate of technical substitution (MRTS); Types of factor substitution; Iso cost line - Properties; Least cost combination (LCC)
27 Product - Product relationship; Production possibility curve - properties; Relationship among the products; Marginal rate of product substitution; Iso revenue line - characteristics - Optimum product combination
28 Returns to scale; Differences between returns to scale and law of variable pro portions
29 Seven principles of farm management - Law of diminishing returns, Principle of factor substitution, Principle of product substitution,
30 Seven principles of farm management - Minimum loss principle, Principle of equi - marginal returns / Opportunity cost principle
31 Seven principles of farm management - Principle of comparative advantage, Time comparison principle.
32 Types of farming - Forms of farm business organizations

Practicals

1 Consumer surplus
2 Consumer equilibrium
3 Measurement of elasticities of demand
4 Seven types of production costs - Tabular and Graphical presentation
5 Classical production function-Graphical illustration of three stages of production
6 Determination of optimum level of input use and output to produce.
7 Determination of least cost combination of resources
8 Determination of optimum product combination
9 Principle of equi-marginal returns
10 Time comparison principle: Compounding & Discounting
11 & 12 Farm holding survey
13 Methods of computation of depreciation - straight-line, declining balance, and sum-of-the-years' digits methods
14 Enterprise budget
15 Cost concepts and farm income measures
16 Break even analysis

Suggested Readings

1. Subba Reddy S., Raghu Ram P., Neelakanta Sastry T P and I Bhavani Devi. 2004. Agricultural Economics. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi
2. Dewett K K and S Chand. 1987. Elementary Economic Theory. S Chand and Co., New Delhi,
3. www. core-econ.org
4. Paul A Samuelson and William D Nordhus. 1985. Economics. McGraw Hill Publishers, New Delhi
5. Raju V T and D V S Rao. 2006. Economics of Farm Production and Management. Oxford & IBH Publishing Co. New Delhi.
6. Johl, S S and T R Kapur. 2009. Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi
7. Ravi Kumar K N. 2012. Microeconomic Analysis in Agriculture. Daya Publishing

House, New Delhi
8. Ravi Kumar K N and G Kalyan Chakravarthy. 2017. Farm Managerial Economics. Astral Intl. Pvt. Ltd., New Delhi
9. Dewett K K and M H Navalur. 2010. Modern Economic Theory. Vikas Publishing House, Ghaziabad

MDC 341
AGRICULTURE MARKETING AND TRADE
3 (2+1)

Objective

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

Course Outlines

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 & DMI - Their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & 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; Com-

putation of marketable and marketed surplus of important commodities; Study of price behaviour overtime for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions - NAFED, SWC,CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Lecture Outlines

Theory

1. Agricultural Marketing - Concepts and definitions of market, marketing, agricultural marketing; Importance of agricultural marketing in economic development of a country
2. Market structure and components; Dynamics of agricultural marketing - Conduct and Performance
3. Classification and characteristics of agricultural markets based on different criteria
4. Demand and Supply - Determinants of Demand for and supply of farm products
5. Producer's surplus - meaning and types, marketable and marketed surplus, factors affecting marketable surplus of major agricultural commodities
6. Marketing process - Concentration, Equalization and Dispersion
7. Market functions - Classification - Kohls and Uhl's classification - Thomsen's classification - Functional approach
8. Physical functions - Packaging and Packing - Transportation - Processing and Storage - Meaning and Importance
9. Exchange functions - Buying and Selling - Meaning - Different methods of sale of agricultural produce in India
10. Facilitating functions - Grading and Standardization - Branding - Market financing - Market intelligence - Risk bearing - Meaning and Importance
11. Risk in agricultural marketing - Types of risks - Speculation and Hedging
12. Future trading in agricultural commodities - Forward markets and Future markets - Meaning, advantages and disadvantages
13. Commodity exchanges in India - Role and Importance of MCX, NCDEX, NMCE, ICEX and Ace Derivatives
14. Market functionaries - Types and importance of agencies involved in agricultural marketing
15. Marketing channel - Meaning and definition; Marketing channels for major agricultural commodities
16. Price spread - Meaning and definition; Marketing costs; Marketing margins; Factors affecting cost of marketing; Reasons for higher marketing costs of agricultural commodities - Ways of reducing marketing costs; Marketing efficiency - Meaning and types
17. Supply Chain Management and Value Chain Management - Importance
18. Marketing mix - Meaning; 4Ps of Marketing - Characteristics and their importance in agriculture pricing
19. Quality control and labeling - AGMARK, HACCP, FSSAI, CODEX - Need and Importance
20. Pricing of agricultural products - Pricing considerations - Approaches - Cost based

pricing and Competition based pricing - Merits and Demerits
21. Market segmentation - Meaning and Importance - Types and benefits of market segmentation; Market Integration - Definition and Types
22. Market promotion - advertising, personal selling, sales promotion, public relations, direct marketing, celebrity endorsement / sponsorship, and digital marketing - meaning, merits and demerits
23. Agricultural price policy - Meaning and functions of price - Administered prices – Need for innovations in agricultural price policy
24. Role of Government in agricultural marketing; Public sector institutions - DMI, CWC, SWC, FCI, CACP, NAFED, MARKFED, Rythu Bazars - Objectives and Functions
25. APMC - Model Regulated Markets Act - Features and its relevance in the present day context
26. Farmer Producer Organization - Farmer Producer Company - Meaning and Importance - Contract Farming - Meaning and Importance
27. Online marketing of agricultural commodities
28. International trade - Concept and its need - Theories of absolute advantage and comparative advantage - Balance of trade
29. Present status and prospects of international trade in agricultural commodities
30. GATT and WTO - Genesis, Objectives, Importance
31. Agreement on Agriculture (AoA) and its implications on Indian agriculture
32. Intellectual Property Rights (IPRs) - TRIPS - Trademarks, Copyrights, Patents, Geographical Indicators, Industrial designs, Trade secrets and Protection of New Plant Variety - Implications on Indian Agriculture

Practicals

1. Plotting and study of demand curve and supply curve for major agricultural commodities
2. Calculation of elasticities, equilibrium quantity and equilibrium price from demand and supply equations
3. Construction of index numbers - Moving averages, General PI, WPI, CPI
4. Correlation analysis between market arrivals and market prices of major agricultural commodities
5. Determinants of market prices of major commodities (Regression analysis) and interpretation of findings
6. Trend fitting of market arrivals and prices of major commodities
7. Computation of marketable surplus and marketed surplus of major commodities
8. Identification of marketing channels for major commodities
9. Collection of data and estimation of marketing cost, marketing margin and price spread
10. Calculation of marketing efficiency by different methods
11. Study on comparative advantage of different agricultural commodities of India in international trade - Calculation of RCA and RSCA
12. Visit to APMC / Regulated market to study the regulation of various market prices
13. Visit to SWC / CWC / FCI to study the objectives, role, organization, functioning and performance
14. Visit to Agri input Unit – Seed / Fertilizer / Agro processing unit to study the objectives and functioning
15. Visit to Rythu Bazar to study the objectives and functioning

16. Visit to FPOs - to study the objectives, organization, functioning and performance

Suggested Readings

1. Acharya S S and N L Agarwal. 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chhina S S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Publishers, New Delhi.
3. Dominick Salvatore. 2006. Micro Economics. McGraw Hill Publishers, New Delhi
4. Kohls Richard, L and N Uhl Josheph. 2002. Marketing of Agricultural Products. Prentice-Hall of India Private Ltd., New Delhi.
5. Philip Kotler and Gary M Armstrong. 2018. Principles of Marketing. Pearson Prentice-Hall, New Delhi.
6. Lekhi R K and Singh Joginder. 2006. Agricultural Economics. Kalyani Publishers, New Delhi.
7. Memoria, C B., Joshi, R L and N I Mulla. 2003. Principles and Practices of Marketing in India. Kitab Mahal, New Delhi.
8. Mukesh Pandey, Mukesh and Tewari Deepali. 2004. Rural and Agricultural Marketing: Opportunities, Challenges and Business Strategies. International Book Distributing Co. Ltd, New Delhi.
9. Sharma R. 2005. Export Management. Laxmi Narain Agarwal Publishers Agra
10. Kahlon A S and D S Tyagi. 1983. Agricultural Price Policy in India. Allied Publishers Pvt. Ltd. New Delhi.
11. Ravi Kumar K N. 2014. Agricultural Marketing. Daya Publishing House, New Delhi.

AECO 341
AGRICULTURAL FINANCE AND COOPERATION
2 (1+1)

Objective

1. To impart knowledge on issues related to lending to priority sector, credit management and financial risk management

Course Outlines

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 offinance 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 multipurpose 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, signif-

icance and limitations and the potential of the newly launced '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.

Lecture Outlines

Theory

1. Agricultural Finance - Meaning, definition, scope and significance - Micro and macro finance - credit needs and its role in Indian agriculture
2. Credit - Meaning and definition; Classification of credit based on different criteria - time, purpose, security, liquidity, contact, approach, activity orientation, and lender
3. Credit analysis: Economic feasibility tests - 4 Rs of credit analysis - Risk, Response, Revenue, and Retention; 3Cs of Credit - Character, Capital, and Capacity; Seven Ps of credit
4. Sources of Agricultural Finance - Institutional and Non Institutional sources; Commercial Banks - Social control and Nationalisation of commercial Banks; Objectives and importance of Nationalization
5. Lead bank scheme - Origin, objectives, functions - Regional Rural Banks (RRBs) - Origin, objectives, features and functions - RRBs in Andhra Pradesh
6. Micro finance - Meaning, importance; Agencies providing microfinance - Banks, NBFCs, and MFIs; Micro Finance Lending and Control Act in Andhra Pradesh - Objectives and important features
7. Crop loan system - Objectives and importance; Scale of finance - Meaning and Objectives; Unit costs - Cost of credit - Kisan Credit Card (KCC)
8. Higher financing institutions - RBI, NABARD, ADB, IMF, World Bank Group and DICGC - Origin, objectives, functions and role in agricultural development
9. Recent development of agricultural credit in India; Financial inclusion; Schemes of GoI - PM KISAN, PMMY, PMKMY, PMJDY
10. Financial Statements - Importance; Balance Sheet and Income Statement - Meaning and components
11. Project - Meaning and Definition; Project Cycle – Phases; SWOT analysis; Time value of money
12. Brief history of cooperative development in India; Maxims of cooperation
13. Principles of cooperation; Types of Agricultural Cooperatives - Credit, marketing, consumer, multi- purpose, farmers' service, processing, and farming cooperatives; cooperative warehousing
14. Role of Cooperative Organisations - ICA, NCUI, NCDC, NAFED

15. Study of successful cooperative organisations: AMUL - Gujarat; AAVIN -Tamil Nadu; Nandini - Karnataka; Maharashtra, Punjab and Andhra Pradesh
16. Crop insurance - Meaning, scope and evolution; Pradhan Mantri Fasal Bima Yojana (PMFBY) - Salient features

Practicals

1. Optimum allocation of limited capital among different enterprises
2. Analysis of progress and performance of cooperatives, commercial banks and RRBs w.r.t. agricultural credit using published data
3. Visit to a Commercial bank to acquire first-hand knowledge of management, schemes and procedures for availing loan
4. Visit to a District Central Co-operative Bank (DCCB) to study its role, functions, procedures for availing loan and fixation of scale of finance
5. Estimation of credit requirement of farm business
6. Analysis of balance sheet - A case study
7. Analysis of income statement - A case study
8. Preparation of bankable projects / farm credit proposals - A case study
9. Appraisal of loan proposal - A case study
10. Techno economic parameters for preparation of projects - Undiscounted measures
11. Techno economic parameters for preparation of projects - Discounted measures
12. Preparation of repayment plans of credit
13. Visit to a co-operative society to acquire first-hand knowledge of manage ment, schemes and procedures
14. Estimation of indemnity of crop insurance

15&16. Seminar on selected topics

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 publishing Co. Pvt. Ltd. New Delhi
3. William G Murray and G Nelson Aarson. 1960. Agricultural Finance. The Iowa State University Press, Iowa.
4. Muniraj R. 1987. Farm Finance for Development. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi
5. Joshi S S and C V Moore.1970. Essentials of Farm Financial Management. Today and Tomorrow's Printers and Publishers, New Delhi.
6. Pandey I M. 2024. Financial Management Pearson Prentice-Hall, New Delhi.

ELCT 441
AGRI-BUSINESS MANAGEMENT
4 (3+1)

Objective

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

Course Outlines

Theory

Transformation of agriculture into agribusiness, various stake holders and components of agribusiness systems, Importance of agribusiness in the Indian economy and New Undergraduate Degree Program in Natural Farming. Agricultural Policy, Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro-based industries, Institutional arrangement, procedures to set up agro-based industries, Constraints in establishing agro-based industries, Agri-value chain: Understanding primary and support activities and their linkages, Business environment: PEST and SWOT analysis, Management functions: Roles and activities, Organization culture, Planning, meaning, definition, types of plans, Purpose or mission, goals or objectives, strategies, polices, procedures, rules, programs and budget, Components of a business plan, Steps in planning and implementation, Organization staffing, directing and motivation, Ordering, leading, supervision, communications, control, Capital management and Financial management of Agribusiness, Financial statements and their importance, Marketing Management: Segmentation, targeting and positioning, Marketing mix and marketing strategies, Consumer behavior 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, retail 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.

Lecture Outlines

Theory

1	Agribusiness - Meaning, scope, structure and dimensions
2&3	Components of agribusiness systems: Agricultural input sector - Agricultural production sector - Agricultural processing sector - Marketing and trade sector
4	Importance of agribusiness in Indian economy- Distinctive features of agribu siness management
5	Transformation of agriculture into agribusiness - Various stakeholders in agri business sector
6	Agricultural Policy of India 2000 - Objectives and Components

7	Agro based industries - Importance, need and types
8&9	Institutional arrangement for promotion of agro-based industries – Procedure to be followed to set up agro- based industries - Constraints in establishing agro-based industries
10	Agri-value chain: Primary and support activities and their linkages
11	Strategy formulation for business environment: PEST analysis
12	Strategy formulation for business environment: SWOT analysis
13	Management - Definitions and concepts - Pipeline diagram & Wheel diagram
14	Management functions - Role and activities
15&16	Planning and its importance - Levels of planning - Steps in planning and imple mentation - Types of plans - Characteristics of good plan
17	Components of Business Planning: Goals and objectives, Strategies, Policies, Procedures, Rules, Programmes and Budget
18	Organization function - Meaning and purpose; Staffing - Definition; Staffing process
19&20	Directing, Motivation, Ordering, Leading, Supervision, Coordination, Communi cation and Control - Meaning and Definitions
21&22	Organization culture: Meaning, types and its importance; Management of orga nizational conflicts; Change Management - Group dynamics
23	Decision making - Leadership styles
24	Managing human resources in agribusiness-HR Functions-Role of HR Managers
25	Human resource training and development - Participative management - Labour management relations
26	Production management - Production, plant layout and material handling, operations planning and control
27&28	Inventory - Meaning, definition, types and objectives of inventory; Inventory management - Definition and types
29	Marketing management in agribusiness - Market segmentation - types of market segmentation, Targeting and Positioning
30	Four P's of marketing mix and strategies
31	Product concept - Product line and product mix - Branding of agricultural commodities
32	Product Life Cycle (PLC) - Stages of new product development
33	Pricing policy - Types of product pricing
34	Packaging and its functions - Physical distribution
35&36	Sales and distribution management - Selling, advertising, marketing research, marketing extension, supply chain management for agribusiness
37	Consumer behavior analysis and the buying process
38&39	Capital management in agribusiness; Fixed capital and working capital - Meaning; Types and importance of working capital
40-42	Financial management; Importance of financial statements - Balance sheet, Profit and Loss statement, Cash flow statement, Break Even Analysis - Meaning, components and formats of financial statements
43&44	Analyzing financial statements: Ratio analysis- Liquidity ratios - Leverage ratios - Activity ratios - Turnover ratios - Profitability ratios
45	Project - Meaning and definition; Project cycle; Guidelines for preparation of

project reports

46 Project management techniques - PERT and CPM

47 Project appraisal and evaluation techniques - Undiscounted measures and decision rules - PBP, ROR

48 Project appraisal and evaluation techniques - Discounted measures and deci sion rules - NPW, BCR, IRR, N/K ratio and Sensitivity analysis

Practicals

1 Visit to input based industries: Seed / Fertilizer / Pesticide / Machinery

2 Visit to study output market / product market: Grains / Fruits / Vegetables / Flowers

3 Study of financing institutions - Commercial Bank / Cooperative Bank / RRBs / AFL / NABARD

4&5 Financial statements - Balance sheet, Profit & loss statement – Financial ratio analysis

6 Development of business performance tracking system

7 Break even analysis / Cost volume profit analysis

8 Trend filling and growth rate analysis of prices of agricultural commodities

9&10 Time value of money: Compounding and Discounting techniques; Project ap praisal techniques: Undiscounted measures - PBP, ROR; Discounted measures - NPW, BCR, IRR

11 Networking techniques in project management - PERT and CPM

12 Assessing the economic viability and financial feasibility of agri-input firm - Case study

13 Assessing the economic viability and financial feasibility of agri-output firm - Case study

14&15 Preparation and presentation of Business plan

16 Preparation of project feasibility report for an agribusiness entrepreneur

Sggested Readings

1. Broadway A C. 2016. Textbook of Agri-business Management. Kalyani Publishers, New Delhi
2. Bairwa S L. 2016. Objective on Fundamentals of Agri-business Management. Kalyani Publishers, New Delhi
3. Anjan Mishra, Arunangshu Giri and Debasish Biswas. 2019. Agribusiness Management. Himalaya Publishing House, New Delhi
4. Shoji Lal Bairwa, Chandra Sen, Meena L K and Meera Kumari. 2018. Agribusiness Management: Theory and Practices, Write and Print Publications.
5. Virender Kamalvanshi. 2015. Agribusiness Management. Random Publications
6. David Downey and John K Trocke. 1981. Agri Business Management. McGraw Hill Publications, New Delhi.

AGRICULTURAL ENGINEERING

AENG 251
FARM MACHINERY AND POWER
2 (1+1)

Objectives

1. 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.

Course Outlines

Theory

Status of Farm Power in India, Sources of Farm Power , I.C. engines, working principles of IC engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system: clutch, gear box, differential and final drive of a tractor , Tractor types, Cost analysis of-tractor power and attached implement, Criteria for selection of tractor and machine implements. Familiarization with Primary and Secondary Tillage implement, implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system ofengine, 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.

Lecture Outlines

Theory

1. Farm power - Different farm power sources, their advantages and disadvantages; Status of farm power in India.
2. Internal combustion engine - Different components and their functions-Working principles of four stroke and two stroke cycle engine- Comparison between diesel and petrol engine- Difference between four stroke and two stroke engines.
3. Terminology related to engine power - firing order, ip, bp, fp, dp, compression ratio, stroke-bore ratio, piston displacement, mechanical efficiency, TDC and BDC; Numerical problems on calculation of ip, bp, mechanical efficiency, compression ratio and stroke-bore ratio.
4. Fuel supply and ignition systems of I.C. engine - Types, components and their functions, working principle of fuel supply systems in petrol and diesel engines; work-

ing principle of petrol battery ignition system.

5. Lubrication and cooling systems of I.C engine - Types, components and their functions working principle of forced feed lubrication system in IC engine; working principle of forced circulation cooling system.
6. Farm tractor– Tractors classification, types, points to be considered in selection of tractors, power transmission system in the tractor; estimating the cost of operation of tractor power and farm machinery.
7. Tillage - Primary tillage, secondary tillage and their objectives - M.B. plough- functions, constructional features, operational adjustments and maintenance.
8. Disc plough - Functions, constructional details, operational adjustments and maintenance, chisel plough and sub-soiler.
9. Harrows - Types, functions, operation of disc harrows; Cultivators - Rigid and spring loaded tyne types; Rotovator,. puddler and cage wheel.
10. Land levelling equipment - Levelling blade, bund former and ridger.
11. Sowing equipment-Seedcumfertilizerdrills - Types, functions, functional components - Type of metering mechanisms, calibration of seed drill.
12. Introduction to planters and transplanters; Intercultural implements - Hoes and weeders for dry and wetland cultivation.
13. Plant protection equipment - Types of sprayers; constructional features ofknapsack sprayer, hand compression sprayer, foot sprayer, rocker sprayer and power sprayer (engine and tractor operated); care and maintenance of sprayers.
14. Dusters–Hand operated and power operated dusters; duster care and maintenance.
15. Harvesting equipment - Sickle, mower, alignment and registration in mower, self-propelled reaper.
16. Threshing – Principle of threshing and components of threshers; Introduction to combine harvester and working principles of combine harvester.

Practicals

1	Showing the difference between EC and IC engines; Constructional details of IC engine.
2	Dismantling of IC engine and explaining the functional aspects of components.
3	Familiarizing with fuel supply and ignition systems of an engine.
4	Familiarizing with lubrication and cooling systems of an engine.
5	Familiarizing with dash board, clutch, gearbox, differential, final drive and PTO of tractor along with brake, steering and hydraulic controls.
6&7	Tractor driving.
8	Mini tractor/Power tiller operation.
9	Attachment of an implement by using 3-point hitch system of a tractor.
10	Familiarization with primary tillage implements like M.B.Plough, discplough and its adjustments; Calculation of field capacities and power requirement of implements.
11	Study of secondary tillage implements and its constructional details Emphasis on disc harrow, spike tooth harrow, blade harrow, rotavator, power harrow;
12	Familiarization with seed metering mechanism and its calibration; Calculation of seed rate.
13	Study on planters and transplanters
14	Practicing with plant protection equipment, different types of sprayers and dusters.

15 Familiarization with inter-cultural equipment and different types available in the market.
16 Exposure on harvesting equipment and combine harvester.

Suggested readings

1. Jagadishwar Sahay-Elements of Agricultural Engineering.
2. Jain, S.C and C.R.Rai. Farm Tractor–Maintenance and Repair. Standard Publishers, 1705-B, Nai Sarak, Delhi-110006.
3. Ojha,T.P. and A.M. Michael. 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.

AENG 351
RENEWABLE ENERGY IN AGRICULTURE AND ALLIED SECTORS
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.

Course Outlines

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, bio diesel and bio oil production and their utilization as bio energy resource, introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photo voltaic system and their application, introduction of wind energy and their application. Availability of biomass and their application in different places

Practicals

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

Lecture Outlines

Theory

1. Classification of energy sources; conventional and non-conventional energy sources, importance of non-conventional sources. Advantages of renewable energy, obstacles to implementation of renewable energy systems.
2. Biomass, classification of biomass, Biomass conversion technologies; Thermo-chemical and bio- chemical conversion technologies.
3. Biogas plants; Introduction, anaerobic digestion, factors affecting bio- digestion.
4. Classification of biogas plants, Continuous and batch type plants, dome and drum type, different variations in dome types.

5. Biogas plants; Advantages and disadvantages of floating drum and fixed dome type plants, KVIC biogas plants, Janata type biogas plants.
6. Digester design considerations, volume of digester for biogas production using cow dung, numerical on biogas plant design.
7. Gasifiers; definition, advantages, construction and working principle of different type of gasifiers.
8. Densification of biomass, briquetting machines, biomass combustion, Furnaces for biomass combustion.
9. Biodiesel preparation; principles, transesterification, process for production of bio diesel from jetropa, waste oil etc.
10. Fermentation process of biomass, Production of Ethanol from Agricultural produces such as sugarcane, grains.
11. Solar energy; introduction, types of solar radiations, flat-plate collectors, concentrated type collectors.
12. Solar thermal applications; box type cooker, dish type cooker, solar water heating system, solar still, space heating, solar pond.
13. Solar grain dryers; solar cabinet dryer, solar convective dryer, solar green house
14. Solar cell, solar photovoltaic applications, solar water pumping system, solar street lights, solar refrigeration system.
15. Wind energy; nature of the wind, wind energy collectors, classification, horizontal and vertical axis wind turbines.
16. Components of WECS, applications of wind energy.

Practicals

1. Demonstration of KVIC biogas plant
2. Demonstration of Janata & Deenabandhu biogas plants
3. Demonstration of different types of gasifiers
4. Demonstration of briquetting machines
5. Demonstration of different types of furnaces
6. Demonstration of box type solar cooker
7. Demonstration of paraboloid concentrating collector
8. Demonstration of solar water heater
9. Demonstration of solar grain dryers
10. Visit to Biogas plants/ Briquetting machinery
11. Demonstration of solar Water pumping unit
12. Demonstration of grid type domestic SPV system
13. Demonstration of non-grid type SPV system
14. Visit to solar park
15. Visit to NERDCAP
16. Final Practical Examination

Suggested Readings

1. Rai.G.D.2017.Non - Conventional Energy Sources. Khanna Publishers, New Delhi.
2. Rathore N.S, Mathur and Kothari.S.2007. Alternate Sources of Energy. ICAR publications, New Delhi
3. Sukhatme.S and Nayak.J.2008.Solar energy: Principles of Thermal collection and Storage. Third Edition.

SEC VI
POST HARVEST PROCESSING TECHNOLOGY
2 (0+2)

Practicals

1. AENG - Measurement of moisture content and calculation on wet basis and dry basis
2. AENG - Determination of EMC
3. AENG - Determination of size of grains
4. AENG - Determination of bulk density of grains
5. AENG - Determination of true density/particle density of grains
6. AENG - Determination of porosity of grains
7. AENG - Determination of angle of repose and coefficient of friction of grains
8. AENG - Study of different size reduction machines
9. AENG - Study of different types of mixers
10. AENG - Study of different types of conveying and elevating equipments
11. AENG - Study of various types of dryers
12. AENG - Study of cleaning, sorting and grading equipment of grains
13. AENG - Study of different equipments for rice mill
14. AENG - Study of pulse/dhal mill
15. AENG -Study of oil expellers
16. AENG - Processing and preparation of value added product from cereals
17. AENG - Processing and preparation of value added product from pulses
18. AENG - Processing and preparation of value added product from oil seeds
19. AENG - Determination of oil content in oil seeds
20. AENG - Testing and performance evaluation of groundnut decorticator
21. AENG - Study of different types of winnowers
22. AENG - Study of green houses
23. HORT - Drying and Dehydration of fruits and vegetables
24. HORT - Methods of pre cooling for fruits and vegetables
25. HORT - Waxing of fruits
26. HORT - Preservatives in Processing of fruits and vegetables
27. HORT - Preparation of fruit jam
28. HORT - Preparation of Squash
29. HORT - Preparation of Pickles.
30. HORT - Visit to food processing industry
31. AENG - Visit to dhal mills
32. AENG - Visit to oil mills

Suggested Readings

1. Post harvest of cereals, pulses and oil seeds, Chakarvarthy, A 2008, Oxford and IBH Publishing. Co.Ltd., New Delhi
2. Unit operations of Agricultural processing, Sahay, K.M and, Singh, K.K 1994. Vikas Publishing house, Pvt Ltd, New Delhi.
3. Post harvest technology of fruits and vegetables (Principles and practices),Pandey,RH, Saroj Prakashan,Allahabad.

SEC XIII
FOOD PROCESSING
2(0+2)

Practicals

1. AENG - Determination of moisture content and its calculation on wet basis and dry basis
2. AENG - Mechanical drying of foods
3. AENG - Experiment on osmotic dehydration of foods
4. AENG - Determination of rehydration ratio of Dehydrated foods
5. AENG - Experiment on blanching of foods
6. AENG - Determination of physical properties of milk
7. AENG - Determination of microbial properties of milk
8. AENG - Experiment on cream separator to determine the separation efficiency
9. AENG - Determination of fat content of milk
10. AENG - Determination of head rice of yield
11. AENG - Determination of cooking properties of raw rice
12. AENG - Determination of cooking properties of parboiled rice
13. AENG - Study of different types of microorganisms pertaining to foods
14. AENG - Determination of microbiological load in food products
15. AENG - Estimation of protein content in foods
16. AENG - Determination of ash content of foods
17. AENG - Experiment on production of sorghum flakes
18. AENG - Experiment on production of pop-corn
19. AENG - Experiment on production of flaked rice
20. HORT - Drying of fruit/vegetables and green leafy vegetables using a cabinet dryer
21. HORT - Preservation of foods through pickling
22. HORT - Preservation of foods using chemical preservatives
23. HORT - Preservation of foods with high concentration of sugar (jam)
24. AENG - Preservation of foods using sterilization temperatures
25. AENG - Preservation of bread/cake using mold inhibitors
26. HORT - Preservation of foods using acid (vinegar)
27. HORT - Drying of Mango & Tomato pulp using foam mat drying
28. HORT - Processing technology for preparation of Jelly
29. HORT - Processing technology of squash
30. HORT - Processing technology of cordial
31. HORT - Evaluation of quality parameters physical, chemical and sensory in value added products of vegetables and fruits
32. AENG - Visit to Dairy plant

Suggested Readings

1. Outlines of dairy technology, Sukumar,De Oxford university press, New Delhi.
2. Fundamentals of food processing, Rao, DG, PHI learning pvt Ltd, New Delhi
3. Unit operations of Agricultural processing, Sahay , K.M and, Singh, K.K 1994. Vikas Publishing house, Pvt Ltd, New Delhi.

ELCT 451
SOIL AND WATER CONSERVATION ENGINEERING
4 (3+1)

Objective

1. To make the students acquainted with the different causes of soil erosion and water loss and the different measures for soil and water conservation.

Course Outlines

Theory

Soil erosion: Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion: Mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation - Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE>25 and EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soilerosion- Run-off plots, soil samples.

Water erosion control measures: Agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gullyand ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump.

Soil erosion control structures- Introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and dropinlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis.

Wind erosion: Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

Water harvesting techniques: Classification based on source, storage and use, runoff harvesting short- term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Practical

Estimation of soil loss by USLE, computation of rainfall erosivity index, computation of soil erodibility index in soil loss estimation; Determination of length of slope (LS) and cropping practice(CP) factors; Estimation/ measuring techniques of soil loss; Study of rainfall simulator for erosion assessment, estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor; Determination of sediment concentration through oven drying method. Calculation of rate of sedimentation and storage loss in

tanks; Study on sedimentation of reservoirs; Design and layoutof contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond- design, capacity and estimation; Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway; Hydraulic and structural design of chute spillway, design of SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Designof water harvesting structures; Study on prioritization of watershed; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed.

Lecture Outlines

Theory

1. Surveying – definition and objectives of survey, primary divisions of surveying, geodetic and plane surveys, classifications, uses of surveys.
2. Instruments used in chain survey -constructional details of metric chain, metallic and steel tapes, ranging rods, arrows, cross-staff, optical square, plumb bob and pegs.
3. Errors in length measurement due to incorrect chains, numerical problems on distance and area corrections.
4. Ranging - definition and methods of ranging, procedure for direct and indirect ranging.
5. Chain triangulation - principle, survey stations, location of survey stations, base-line, check line, tie line, offsets.
6. Plotting procedure of chain survey, conventional symbols
7. Areas of irregularly bounded fields - different methods.
8. Numerical problems on Simpson's, trapezoidal rules.
9. Leveling - definition, description of dumpy level and leveling staff. Terminology connected with leveling - datum, elevation, station, back sight, fore sight, intermediate sight, height of instrument, bench mark and its types, change point.
10. Leveling procedure - temporary adjustments in dumpy level, level field note book, recording procedure in level field note book.
11. Reduction of levels - height of collimation method, rise and fall method, and numerical problems connected with these two methods.
12. Types of leveling - simple, leveling, differential leveling and profile leveling.
13. Contour survey - definition, characteristics and uses of contours.
14. Introduction to Soil and Water Conservation and causes of Soil Erosion.
15. Design of contour bund, height of contour bund
16. Earth work computation by using contour bunding and terracing
17. Graded bunds, design of graded bunds Construction and alignment of bunds.
18. Terracing - classification,introduction to bench terraces and broad based terracing
19. Bench terraces - types planning and design
20. Deign of graded terraces, runoff from terrace, and channel capacity.
21. Layout procedure of bench terracing alignment and area lost for cultivation.
22. Grassed water ways and their design.
23. Introduction to trenches and types of trenches
24. Farm pond, introduction types, selection site for farm pond.
25. Water harvesting techniques, lining of ponds, tanks and canal systems.

26. Irrigation - definition, classification of irrigation projects, benefits and ill effects of irrigation, flow irrigation and lift irrigation.
27. Wells and classification of wells, aquifers
28. Water lifting devices - classification of pumps, centrifugal pump, principle of operation.
29. Pump characteristics - pump efficiencies, capacity calculation based on irrigation scheduling, power calculations of centrifugal pump.
30. Deep well pumps - Turbine and submersible pumps, installation and working principles of these pumps.
31. Measurement of irrigation water - Importance. Methods of measuring water – volumetric and area, velocity method.
32. Direct discharge methods - water meter, weirs, orifices.
33. Parshall flume - installation of these devices, conditions for weir installation
34. Discharge calculation of rectangular and triangular weirs, advantages of parshall flume over the weirs.
35. Water conveyance systems - open channel, definitions of wetted perimeter, hydraulic radius, hydraulic slope, area of cross section and free board. Manning s formula for estimating mean velocity, side slopes of channels for different soils
36. Underground pipeline, advantages of earthen channels, disadvantages, type of pipes recommended for underground pipeline.
37. Components of underground pipe line, installation procedure, discharge calculation of underground pipe line.
38. Temporary Gulley control structures - Types brushwood dams and wiremesh dames etc.
39. Permanent Gulley control structures - Components of permanent structures and design.
40. Watershed - Introduction concept and characteristics Watershed development and identification of watersheds.
41. Indigenous micro irrigation devices.
42. Irrigation methods - sprinkler irrigation, scope, functional components of sprinkler system and their working.
43. Types of sprinkler irrigation, operation and maintenance of the system, cost economics.
44. Historical development of Drip irrigation systems advantages and limitations
45. Functional components of drip system and their working principles.
46. Water distribution system of Drip irrigation system
47. Operation and maintenance of the drip system, cost economics.
48. Rainport irrigation and Laser Irrigation system

Practicals

1. Study of different Components of Drip Irrigation systems
2. Study of different Components of Sprinkler Irrigation systems
3. Study of different Components of Laser Irrigation systems
4. Study of different Components of Rain Port Irrigation systems
5. Study of different filters of Drip Irrigation systems
6. Determination of Precipitation pattern, discharge and uniform coefficient
7. Evaluation of Cost Economics of Drip Irrigation system
8. Evaluation of Cost Economics of Sprinkler Irrigation system

9. Field visits of near by places of Drip Irrigation system
10. Field visits of near by places of Sprinkler Irrigation system
11. Computation of water discharge by different methods
12. Capacity calculations of open channels.
13. Design calculations of under ground pipe line systems.
14. Numerical Calculations of Irrigation efficiencies
15. Visit to Farmpond
16. Final Practical Examination

Suggested Readings

1. Land and water management -VVN Murthy, Kalyani Publications, New Delhi
2. Principles of Agricultural Engineering, AM Michael and TP Ojha, Jain brothers, New Delhi
3. Principles of Drip Irrigation, Mane M.S and Ayare B.L.Jain brothers, New Delhi
4. Principles of Sprinkler Irrigation, Mane M.S and Ayare B.L Jain brothers, New Delhi
5. Irrigation theory and practice, AM Michael,Vikas Publications, New Delhi

CROP PHYSIOLOGY

VAC 161
ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT
3 (2+1)

Objective

1. To expose and acquire knowledge on the environment and its protection.
2. To gain the state-of-the-art - skill and expertise on management of disasters.

Course Outlines

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance- Multi disciplinary 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, rainwater 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, seaaccidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management frame work; 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 watersample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem– Visit to pond/river/hills. Visit to areas affected by natural disaster.

Lecture Outlines

Theory

1. Definition, scope and importance of Environmental studies, multidisciplinary nature of environmental studies-need for public awareness.
2. Contribution of different scientists, social activists and institutions in relation to environmental studies.
3. Segments of Environment: Spheres of Earth - Lithosphere, Hydrosphere, Atmosphere - Different layers of atmosphere. Natural Resources: classification.
4. Forest resources: Forest functions- Ecological Significance- Deforestation - Causes and consequences of deforestation on environment - Mangroves protection and significance. Forest protection-Chipko movement and Joint forest management.
5. Water resources: Sources of water- consumption pattern- reasons for decline of ground water - sustainable water management -Public water distribution system-Benefits and problems of dams- Environmental movements against large dams - Narmada bacho andolan.
6. Mineral resources: Types of Mineral Resources- Fuel, metallic and non-metallic mineral resources - uses and exploitation- distribution of mineral resources - Methods of Mineral Exploration and their effects on environment.
7. Food resources: World food problems and environmental concerns-Concept of food security - Options to Achieve Food Security.
8. Energy resources: Classification- Types of renewable energy resources- advantages and disadvantages -environmental impact of different renewable energy resources.
9. Types of non-renewable energy resources - advantages and disadvantages -environmental impacts of different non- renewable energy resources.
10. Land resources: Land degradation - mechanisms and causes that initiate land degradation- Desertification -causes and control- Land use planning- policies in Land use planning -case studies.
11. Soil resources: Types of soils -Types of soil erosion- causes and consequences of soil erosion - strategies for soil conservation- Role of an individual in conservation of natural resources.
12. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem- Types of ecosystems- Characteristic features of crop ecosystem.
13. Biodiversity and its conservation: Introduction, definition, types of biodiversity, methods to measure biodiversity- Biogeographical classification of India.
14. Importance and Value of biodiversity: Biodiversity hot spots- Threats and Conservation of biodiversity- Biodiversity act 2022- National biodiversity authority and its functions.
15. Environmental Pollution: Definition, causes, effects and control measures of Air pollution-Air quality standards of Central pollution control board.
16. Definition, causes, effects and control measures of ground water pollution and surfacewater pollution- concepts of eutrophication and bio-magnification- case studies.

17. Definition, causes, effects and control measures of Marine pollution - case studies on marine oil spills. Definition, causes, effects and control measures of Soil pollution and Noise pollution.
18. Definition, causes, effects and control measures of Thermal pollution and light pollution.
19. 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.
20. Government policies and schemes on waste management – Swachh Bharat mission-National action plan on waste management (Hazardous waste, E- waste, municipal solid waste, bio medical waste, plastic waste and batteries management).
21. Social Issues and the Environment: Urbanization and urban problems related to energy - Water conservation, rain water harvesting and watershed management-case studies
22. Environmental ethics: Issues and possible solutions- causes and consequences of global warming- Climate change and its influence on agricultural productivity-measures to reduce GHGs-Acid rain- Ozone layer depletion.
23. Salient features and provision of Environment Protection Act, 1986- Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act -Wildlife Protection Act- Forest Conservation Act.
24. Environment and human health: Human Population and the Environment- various initiatives of government on Human Rights-Value Education- Women and Child Welfare.
25. Role of Information Technology in Environment and human health- case studies.
26. Disaster - definition and Types of disasters - Natural Disasters - Floods, drought, cyclone, earthquakes- their effects and management.
27. Natural disasters -landslides, avalanches, volcanic eruptions, Heat and cold waves -El Nino- La Nina- their effects and management.
28. Man Made Disasters - Nuclear disasters/ nuclear accidents and holocaust, chemical disasters, biological disasters - their effects and management- case studies.
29. Man Made Disasters - forest fires, building fire, coal fire, oil fire, road accidents, rail accidents, air accidents, sea accidents- their effects and management.
30. Concept of disaster management-International and National strategy for disaster reduction- national disaster management framework and financial arrangements.
31. Role of NGOs- community based organizations and media in disaster management-Role of Central, state, district and local administration in disaster control.
32. Role of armed forces in disaster response-Police and other organizations in disaster management- National disaster response force-their impact and management - recent case studies.

Practicals

1. Environmental sampling: Collection, processing, preservation and storage of water samples .
2. Water quality analysis: pH, EC, Acidity and Alkalinity.
3. Estimation of TDS in water samples.
4. Estimation of temporary hardness of water samples.
5. Estimation of total hardness of water samples.
6. Estimation of DO and BOD in water samples.

7. Determination of COD in water samples.
8. Visit to a local area to document environmental assets (viz.,river/forest/grassland/hill/mountain)and Visit to a local polluted site.
9. Visit to wind mill / hydro power / solar power generation units.
10. Study of simple ecosystem - Visit to pond/river/hills.
11. Assessment of Biodiversity in farming system-Estimation of species abundance.
12. Assessment of Suspended Particulate Matter (SPM) inRespirable and Non respirable dust .
13. Enumeration of E. coli in water samples.
14. Estimation of heavy metals in the water samples using AAS.
15. Estimation of sound pollution and light pollution.
16. Visit to in-situ and ex-situconservation sites.

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. DharChakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bengaluru. 36 pp.
3. ErachBharucha. Text book for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. UmeshKanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi.
5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104.
6. Agrotech Publishing Academy, Udaipur 6. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India.
7. Tyler, Miller and Spoolman, Scot. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

CPHY 361
FUNDAMENTALS OF CROP PHYSIOLOGY
3 (2+1)

Objectives

1. 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.

Course Outlines

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, Waterloss by plants: Types of water loss: transpiration, stomatal physiology and guttation, Water use efficiency and factors affecting WUE. Classification of mineral elements: Essential and beneficial elements, Passive and active transport of mineral

element: Nernst equation, ion transport, ion pump and channels, Functions of essential elements and their deficiency and toxicity symptoms, Hydroponics and sand culture. Brief outline of: Photo synthetic apparatus, pigment system, quantum requirement and quantum yield: Structure of chloroplast, Examples of different photo synthetic 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 & II. Introduction to light reaction of photo synthesis, Light absorption by photo synthetic pigments and transfer of energy, Source of O_2 during photo synthesis: 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 & Slack Cycle, CAM Cycle, Significance of these pathways (concept of photorespiration, absence of photorespiration in C4 plant: Productivity of C4 plant, CAM: an adaptive mechanism), Factors affecting photosynthesis (light, temperature, CO_2, O_2 etc). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb 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. Short discussion on factors affecting growth and development. Photoperiodism: Classical works of Garner and Allard. 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 Phyto chrome Introduction to Vernalization (What is vernalization, devernalizationetc). Meaning, classification (seasonal, sequential etc), relation with abscission. Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR), Plant growth inhibitor. Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 –D, GAs, Kinetin etc).

Practical

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

Lecture Outlines

Theory

1. Plant physiology and crop physiology-definitions - Importance of crop physiology in agriculture and allied sciences - Historical milestones- Relationship of crop physiology with other branches of crop science.
2. Over view of plant cell-Plant cell organelles-their structure and function in different plant physiological processes
3. Plant water relations- Structure and properties of water- Physiological roles of water in crop plants -Diffusion and osmosis-definitions- Fick's law of diffusion - Definition of water potential and components of water potential in plant cell.

4. Water absorption by plants: Concept of active and passive absorption - Pathway of water across the root cells via apoplast, transmembrane and symplast pathways
5. Ascent of sap-theories and mechanisms explaining ascent of sap-Cohesion-Tension theory-cavitation or embolism in xylem - Concept of Soil-plant-atmospheric continuum (SPAC) and its significance
6. Water loss by plants: Transpiration - types of transpiration-significance of transpiration-guttation- Stomatal physiology-Structure of stomata in monocots and dicots-Characteristics of stomata (density, size and shape)
7. Stomatal frequency - Distribution and types of stomata- Stomatal opening and closing by active K+ transport mechanism- Antitranspirants- Types of antitranspirants and examples
8. Water Use Efficiency (WUE) and Water Requirement (WR) - WUE and WR of C3, C4 and CAM plants- Transpiration in relation to productivity- Passioura's yield model-Factors influencing WUE
9. Essential element and beneficial element definitions- Criteria of essentiality of plant nutrients- Mengel's classification of essential nutrients- Passive and active transport of mineral nutrients.
10. Functional roles of N,P, K, S, Ca and Mg
11. Functional roles of Fe, Mn, Cu, Zn, B, Mo, Cl, Na, Si, Co and Ni
12. Deficiency symptoms of macro nutrients and their corrective measures,
13. Deficiency symptoms of micro nutrients and their corrective measures
14. Foliar nutrition- Mechanism of uptake- Significance of foliar nutrition - Practical utility in agriculture - Hydroponics - Types of solution culture techniques - Sand culture technique and types of sand culture- Aeroponics- practical applications of hydroponics, sand culture and aeroponics in Agriculture
15. Photosynthesis- Photosynthetic apparatus- Chloroplast and its structure- Photosynthetic pigments (chlorophylls, carotenoids and phycobilins) - structure and role of chlorophyll a and b - Light absorption by photosynthetic pigments - concept of energy transfer during photosynthesis
16. Photosynthesis- Quantum yield and quantum requirement of photosynthesis- Red drop and Emerson enhancement effect - Photosystem-I and II - Light reactions- Hill reaction - Non-cyclic, cyclic and pseudo cyclic photo phosphorylation
17. Photosynthesis- Dark reactions of photosynthesis-CO2 fixation pathways- C3 pathway- Energy requirement- C4 pathway- Variants of C4 pathway- Energy requirement- Significance of C4 pathway
18. Photosynthesis- CAM pathway and its significance- Concept of photorespiration-The C2 photosynthetic carbon oxidative cycle and its significance- Factors affecting photosynthesis
19. Outline of the process of respiration: Definition and importance- Glycolysis, Kreb's Cycle and ETC, - Energy budget of respiratory pathway - Factors affecting respiration.
20. Respiratory quotient-Oxidative Pentose Phosphate pathway-cyanide resistant respiration-SHAM- Concept of growth and maintenance respiration
21. Definition of growth, development and differentiation-Determinate and indeterminate growth- Measurement of plant growth (by fresh weight, dry weight, linear dimension and area methods)- Growth Analysis- Growth parameters- Definitions and mathematical formulae

22. Photoperiodism and flowering- Importance of photoperiodism- Classification of plants based on photoperiodic responses- Perception of photoperiodic stimulus- Biological clock
23. Phytochrome- Structure- Role of phytochrome in inducing flowering in short day and long day plants- Introduction to vernalization- Perception of cold stimulus- De-vernalization- Importance of vernalization
24. Senescence definition- Classification of senescence- Physiological and biochemical changes during senescence- Significance of senescence
25. Abscission and its relationship with senescence - Concept of stay green trait and its importance in Agriculture- hormonal regulation of senescence and abscission -Use of hormones in increasing the vase life of flowers
26. Definition of plant growth regulator, plant hormone, growth inhibitor- growth retardant- Auxins- Occurrence, transport, biosynthesis, mode of action, physiological roles and commercial applications
27. Gibberellins and cytokinins - Occurrence, transport, biosynthesis, mode of action, physiological roles and commercial applications
28. Abscisic Acid (ABA) and Ethylene - Occurrence, transport, biosynthesis, mode of action, physiological roles and commercial applications
29. Novel plant growth regulators- Brassinosteroids,strigolactones, Jasmonates, , salicylic acid and triacontanol- Physiological roles- and Commercial uses
30. Concept of Physiological maturity and harvestable maturity-Fruit ripening-climacteric and non- climacteric fruits-metabolic changes during fruit ripening-ripening induction and ripening inhibition
31. Stress physiology-different types of abiotic stresses-drought, salinity, waterlogging, high and low temperature stresses- their influence on crop productivity
32. Adaptation and tolerance mechanisms of crop plants for drought, waterlogging, temperature and Salinity stress-Concept of osmoregulation

Practicals

1. Preparation of standard Solutions, units of concentration and dilution
2. Effect of moisture stress on seed germination and seedling vigour
3. Measurement of leaf area by various methods
4. Measurement of water potential of plant tissue by Chardakov's Method
5. Measurement of water status of plant in roots, stems and leaves by estimation of relative water content
6. Development of nutrient deficiencies symptoms in hydroponically grown plants
7. Development of nutrient toxicity symptoms in hydroponically grown plants
8. Correction of nutrient deficiency symptoms in crop plants using appropriate chemicals
9. Estimation of photosynthetic pigments and measurement of absorption spectrum
10. Measurement of rate of photosynthesis and transpiration by IRGA
11. Leaf anatomy of C_3 and C_4 plants
12. Plant growth analysis- Calculation of growth parameters
13. Measurement of stomatal frequency and stomatal index
14. Demonstration of effect of cytokinin on chlorophyll retention and Induction of leaf abscission by ethylene
15. Preparation of growth hormone solutions and their effect on plant growth
16. Measurement of microclimate in crop canopies using psychrometer, Light meter

and IR thermometer

Suggested Readings

1. Devlin's Exercises in Plant physiology by Robert Devlin, Frnacis H. Witham and David F. Blaydes
2. Fundamentals of Plant Physiology by Lincoln Taiz, Eduardo Zeiger, Ian Max Molle 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
6. Plant Physiology by S.N. Pandey and B.K. Sinha, 4th Ed
7. Plant Physiology and Development by Lincoln Taiz, Eduardo Zeiger, Ian Max Moller and Angus Murphy, 6th Ed

ELCT 461
MICRO-PROPAGATION TECHNOLOGIES
4 (3+1)

Objective

1. 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

Course Outlines

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

Lecture Outlines

Theory

1. Introduction - terminology in plant tissue culture- micro propogation - definition and significance- meaning and concept of invitro culture- overview of applications in agriculture and conservation- history of plant tissue culture - historical milestones.
2. Plant tissue culture procedure-general techniques of plant tissue culture.
3. Physical, laboratory and environmental requirements of tissue culture unit.
4. Various techniques of sterilization followed in plant tissue culture laboratory.
5. The components of tissue culture media: macro and micro nutrients, organic additions, osmotic and pH effects, plant growth regulators, inhibitors, miscellaneous products and support systems.

6. Preparation of tissue culture media–steps in preparation of culture medium-media selection-types of media-advantages and disadvantages.
7. Genetic control of regeneration-pathways of regeneration of plants.
8. Overview of micro propagation-culture types - cultures of unorganized tissues (callus cultures, suspension (or cell) cultures, protoplast cultures and anther cultures).
9. Cultures of organized structures (organ culture, meristem cultures, shoot tip, or shoot cultures node cultures, isolated root cultures, zygotic embryocultures) patterns of growth and differentiation.
10. Micropropagation-advantages of vegetative propagation over sexual reproduction-stages of micropropagation.
11. Factors affecting invitro stages of micropropagation - applications and limitations of micropropagation.
12. Auxiliary bud proliferation - shoot tip-budculture - meristem tip culture-production of virus free plants - virus elimination by heat treatment.
13. Factors affecting virus eradication by meristem tip - virus elimination through-shoot tip grafting-callus culture-virus indexing.
14. Microbial contamination- bacteria- fungus- identification- characterization - methods to eradicate microbial contamination.
15. Organ culture techniques - shoot and root cultures: methods and applications.
16. Callus culture-induction techniques-applications-significance.
17. Organogenic differentiation - induction of organogenic differentiation - factors affecting shoot - bud differentiation.
18. Ontogeny of shoot buds-totipotency of epidermal cells - totipotency of crowngall cells.
19. Triploid production through endosperm culture and its applications.
20. Factors affecting shoot-bud differentiation in endosperm culture-ontogeny of shoot buds- applications of endosperm culture.
21. Zygotic embryo culture-techniques-culture requirements-role of the suspensor in embryo culture- morphogenesis in the cultures of seeds with partially differentiated embryos-applications.
22. Pathways of pollen development.
23. Haploid production-anther culture-techniques- -factors affecting and rogenesis.
24. Pre-treatment of cultured anthers / pollen grains-culture medium-culture density-ontogeny of androgenic haploids-plant regeneration from pollen embryos.
25. Gynogenesis- production of haploids and distant hybridization-diploidization to raise homozygous diploids-applications and limitations.
26. Somatic embryogenesis-factors affecting somatic embryogenesis-induction and development of somatic embryos.
27. Maturation of somatic embryos-somatic embryos versus zygotic embryos-synchronization of embryo development-large scale production of somatic embryos.
28. Synthetic seeds-types-desiccated synthetic seeds-hydrated synthetic seeds-applications-advantages and limitations of synthetic seed.
29. Invitro pollination-techniques- factors effecting seed set in invitro pollination and applications.
30. Invitro fertilization-steps in invitrofertilization and applications-embryo rescue in wider hybridization–techniques and applications of embryo rescue.
31. Invitro mutagenesis and its applications - genetic variability in the invitro

system-mutagens application in invitro system-choice of mutagens in mutation breeding

32. Cell culture-isolation of single cells-from cultured tissues-suspension cultures - types-techniques- culture medium for suspensions.
33. Cellculture - agitation and synchronization of medium-assessment of growth in suspension cultures- assessment of viability of cultured cells.
34. Single cellculture - techniques of single cell culture-factors affecting single cell culture.
35. Plant cellreactors-selection of a bioreactor -bioreactor designs-applications of cell culture.
36. Cytodifferentiation-factors affecting vascular tissue differentiation-cell cycle and dedifferentiation.
37. Production of secondary metabolites - natural plant products of industrial importance - strategies used to enhance secondary metabolite production.
38. Commercial aspects of secondary metabolite production-case studies.
39. Somaclonal variation-introduction-selection of somaclonal variants at different levels.
40. Origin of somaclonal variation-mechanisms underlying genetic variation.
41. Strategy to produce somaclonal and gametoclonal variants - assessment of somaclonal variation- applications.
42. Protoplast isolation-protoplast purification and protoplast culture techniques.
43. Plant regeneration from protoplast-factors affecting yield and viability of protoplasts.
44. Somatic hybridization and cybridization - protoplast fusion-methods to produce cybrids.
45. Selection of hybrid cells regeneration of hybrid plants - verification of hybridity - genetic consequences of protoplast fusion.
46. Invitro germplasm conservation-role of tissue culture in germplasm conservation and biotechnology.
47. Cryo preservation-germplasm storage-short /medium and long-term storage.
48. Agrobacterium mediated gene transfer and its applications.

Practicals

1. Organization of tissue culture laboratory-identification of various equipment sterili zation technique of tissue culture laboratory-glassware, plastic and metal ware.
2. Preparation of stocks and working solutions.
3. Preparation of different types of media.
4. Sterilization of explants and establishment of a primary culture from explants.
5. Preparation and inoculation of explants for callus production.
6. Preparation and inoculation of explants for direct organo genesis.
7. Determination of optimum concentration of growth hormones/plant growth regulators for direct organogenesis-shoot and root.
8. Preparation and inoculation of explant (single node & shoot tip).
9. Subculturing techniques in plant tissue culture.
10. Plant regeneration and hardening techniques in micropropagation.
11. Liquid culture techniques in plant tissue culture.

12&13 To identify sources of contamination in plant tissue culture and strategies to

reduce contamination rates.

14 Induction and development of somatic embryos.

15 Preparation of synthetic seeds and encapsulation.

16 Visit to commercial tissue culture laboratories.

Suggested readings

1. Bojwani, S.S and Razdan, M.K. (1996). Plant tissue culture: Theory and practice, a revised edition. Elsevier science.
2. Edwin F. George, E.F., Hall, M.A and Klerk, G.J. (2007). Plant Propagation by Tissue Culture, 3rd Edition. Springer.
3. Bojwani, S.S and Dantu, P.K. (2013). Plant tissue culture: An introductory text. Springer.
4. Neumann, K.H., Imani, J and Kumar, A. (2020). Plant cell and tissueculture- A tool in biotechnology basics and applications. Springer.

PLANT PATHOLOGY

PATH 171
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.

Course Outlines

Theory

Introduction to Plant Pathology: Concept of disease in plants; Different terms used in Plant Pathology, History of Plant Pathology with special Suggested Readings 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 equipments, Study of different plant disease symptoms, Microscopic examination of general structure of fungi, Simple staining of bacteria: Directand indirect staining, Gram staining of bacteria, Microscopic examination of fungal diseased specimen, Microscopic examination of bacterial diseased specimen, Preparation of culture media, Isolation ofplant 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

Lecture Outlines

Theory

1. Introduction to Plant Pathology: Definition of Plant Pathology- Objectives of Plant Pathology- Importance of Plant Pathogens- Important famines in history caused by pathogens- Irish Famine- Great Bengal Famine- Coffee Rust
2. History of Plant Pathology with special reference to Indian work- Contributions of P. A. Micheli, Anton von de Bary, M.S.Woronin, M. Ward, P.A.Millardet, T.J. Burril, E.F. Smith, Doi et al., Davis et al.,A.E. Mayer, D. Iwanowski, Beijerinck, W.M. Stanely, Diener, E.C.Stakman, E.J. Butler, B. B.Mundkur, J.F.Dastur, K.C Mehta, T.S. Sadasivan, M.K. Patel
3. Terms used in plant Pathology - Disease - Disorder - Pathogen -Parasite - Pathogenicity - Pathogenesis - Sign - Symptom - Syndrome - Inoculum - Inoculum Potential -Infection - Incubation Period - Latent period- Predisposition - Hypersensitivity -

-Disease cycle- Disease triangle- Disease Pyramid

4. Classification of plant diseases: Based on occurrence (Sporadic, Endemic, Epidemic, Pandemic), Based on host plant affected (Cereals, Millets, Pulses, Oilseeds, Cash crops, Fruit crops, Vegetables, Spices with one example), Based on plant parts affected (Root, Stem, Leaves, Flower, Fruit with one example), Based on symptoms-(Necrotic, Hyperplastic, Hypoplasticetc.)
5. Classification of plant diseases (continued): Based on cause of plant disease with examples of important plant diseases caused by them: Animate- Fungi - (Brown spot, Coffee Rust) Bacteria - (Fire blight of apple, Crown gall of apple) FVB – (Pierce's disease of Grapevine, Citrus greening); Phytoplasmas - (Sesamum Phyllody, Little leaf of Brinjal), Spiroplasma - (Corn stunt, Citrus stubborn); Flagellant protozoa - (Phytomonas- Coffee Pholem necrosis); Green algae- (Red rust) and Parasitic higher plants - (Cuscuta, Loranthus, Orobanche, Striga); Viruses - (TMV, MYMV) and Viroids (Potato spindle tuber viroid, Coconut cadangcadang viroid); Inanimate- Khaira disease, Black heart of potato, blossom end rot of tomato, Purple leaf of cotton
6. Fungus - Definition - Ultra structure of fungal cell - Types of fungal thalli - (Plasmodium, Unicellular and Filamentous) - Fungi based on reproductive structures - (holocarpic, eucarpic), Types of fungi based on their physical presence on or in the host (ectophytic, endophytic and ectendophytic) - Septation in fungi (Primary, adventitious, perforated and dolipore septa).
7. Fungal tissues - plectenchyma (prosenchyma and pseudoparenchyma); Modifications of mycelium (rhizomorphs, sclerotium, stroma, haustorium, rhizoids and appressorium) Parasitism in fungi- saprophytes (obligate saprophytes and facultative parasite) and parasites (obligate parasites and facultative saprophytes); Symbiosis-Mycorrhizae
8. Reproduction in fungi: Asexual reproduction - Fragmentation, Fission, Budding and Sporulation; Plano and Aplanospores. Planospores - types of flagella- tinsel, whiplash; Monoflagellate, Biflagellate - Anisokont and Heterokont zoospores. Conidiophore and Conidiospores (conidia). Asexual fruiting bodies with examples
9. Sexual reproduction - planogametic copulation, gametangial contact, gametangial copulation, spermatization and somatogamy. Sexual spores in fungi
10. Classification of fungi (Kirk et al., 2008): Differences between three Kingdoms in which fungi are placed: Kingdom Protozoa - Taxonomic position and characteristics of Plasmodiophora (club root of cabbage), - Spongospora (Potato powdery scab).
11. Kingdom Chromista: Characteristics of Phylum Oomycota-. Taxonomic position and Distinguishing features of the genera Pythium, Phytophthora, Albugo
12. Kingdom Chromista: Characteristics of Phylum Oomycota (continued) Characteristics of downy mildew genera - Sclerospora, Peronospora, Peronosclerospora, Pseudoperonospora, Plasmopara and Bremia. Examples of diseases caused by each genus
13. Kingdom Fungi - Phylum Chytridiomycota, Characteristics and taxonomic position of Synchytriumendobioticum
14. Kingdom Fungi - Phylum Zygomycota and Characteristics and taxonomic position of Rhizopus
15. Kingdom Fungi - Characteristics of the Phylum Ascomycota along with types of asci and ascocarps

16. Ascospore development in Pyronemaomphaloides
17. Outline the classification of Phylum Ascomycota up to level of genus with the distinguishing characters citing one example of important plant diseases
18. Phylum Ascomycota - Key characters for the identification of powdery mildew genera
19. Phylum Basidiomycota - Important characteristics of the Phylum Basidiomycota - Outline the classification of Phylum Basidiomycota up to genus level (genera that causes Rust, Smut, bunt and Exobasidium, Ganoderma).
20. Phylum Basidiomycota (continued): Macrocyclic, microcyclic, demicyclic rusts; Autoecious and Heteroecious rustswith examples. Life cycle of *Puccinia graminis f. sp. tritici*
21. Anamorphic Fungi (Mitosporic fungi = Fungi Imperfecti) Hyphomycetous anamorphic fungi: Distinguishing characters of Genera *Alternaria,Botrytis, Helminthosporium, Bipolaris, Cercospora, Fusarium, Pyricularia, Mycelia Sterilia - Rhizoctonia, Sclerotium.* Acervular Imperfect Fungi - *Colletotrichum, Pestalotiopsis, Gloeosporium. Pycnidial Imperfect Fungi - Phoma, Phomopsis, Diplodia, Septoria*
22. General morphological characteristics, reproduction and classification of phytopathogenic bacteria citing important Phytopathigenic bacterial genera.
23. Fastidious vascular bacteria (RLOs) - important characteristics, Example of one Genus under xylem inhabiting and Phloem inhabiting along with Gram reaction. *(Leifsonia xyli* (sugarcane ratoon stunt), *Candidatus liberobacter asiaticus (citrus greening) and Xylella fastidiosa (Pierce's disease of grapes).* Phytoplasmas and Spiroplasmas - Important characteristics of Phytoplasma. Examples of plant diseases caused by Phytoplasma (little leaf of brinjal, sesamum phyllody and their vectors) Spiroplasma - corn stunt and citrus stubborn - vectors.
24. Plant Viruses– important characteristics of plant viruses– classification of viruses based on Nucleic acid - single stranded (ss) RNA, double stranded (ds) RNA, ssDNA and dsDNA with one or two examples of viruses causing plant diseases - Methods of transmission of plant viruses.
25. Important characters of viroids- Examples of important viroid diseases - potato spindle tuber and coconut cadang cadang Study of green algae - Brief description of Cephaleuros virescens - Red rust Study of phanerogamic plant parasites with suitable examples - *Cuscuta, Orabanche, Striga, Loranthus*
26. Development of disease in plants: Phases in Pathogenesis- Pre-penetration stage, Penetration stage and Post Penetration.
27. Principles of plant disease management -Exclusion - plant quarantine, Inspection and seed certification - Avoidance of the pathogen (selection of pathogen free propagating materialand seed, selection of field, choice of time of sowing and disease escaping varieties).
28. Eradication- Physical methods of eradication (hot water treatment, soil solarization and solar heat treatment Eradication - Cultural methods of eradication (rouging, eradication of alternate and collateral host, crop rotation, manure and fertilizer management, mixed cropping, sanitation, summer ploughing, soil amendments, time of sowing, seedrate and plant density, irrigation and drainage.

29 Eradication - Biological methods - Mechanisms of biological control with examples - Hypovirulence, cross protection.

30&31 Protection - Chemical methods - Classification of fungicides based on

different criteria like based on formulation, method of application, movement, mechanism of action, chemical group.

32 Host plant resistance - Horizontal resistance, Vertical resistance, Gene for gene hypothesis, PTI and ETI. Vertifolia effect.

Praticals

1. Microscopy - Study of the parts of microscope
2. Acquaintance with various laboratory equipment
3. Study of different plant disease symptoms
4. Preparation of culture media Potato Dextrose Agar (PDA) for fungi and Nutrient Agar (NA) for bacteria
5. Isolation of plant pathogenic fungi and bacteria
6. Purification of plant pathogens
7. Demonstration of Koch's postulates for fungi and bacteria
8. Microscopic examination of Zygomycota and Oomycota genera
9. Microscopic examination of Powdery mildew genera
10. Microscopic examination of Basidiomycota genera
11. Microscopic examination of Mitosporic genera
12. Bacterial staining procedures- Simple staining - Gram's staining
13. Demonstration of mechanical transmission of plant viruses
14. Study of different groups of fungicides and antibiotics
15. Different methods of application of fungicides
16. Calculation of fungicide spray concentrations

Suggested readings

1. Pathak, V. N. Essentials of Plant Pathology. Prakash Pub., Jaipur
2. Agrios, GN. 2005. Plant Pathology. Elsevier Academic Press, Amsterdam
3. Kamat, M. N. Introductory Plant Pathology. Prakash Pub, Jaipur
4. Singh RS. 2008. Plant Diseases. 8 th Ed. Oxford & IBH. Pub. Co., New Delhi
5. Singh RS. 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co. ,New Delhi
6. Alexopoulos, Mims and Blackwel. Introductory Mycology. John Wiley & Sons, New York
7. Mehrotra RS & Aggarwal A. 2007. Plant Pathology. 7 th Ed. Tata Mc Graw Hill Publ. Co. Ltd.
8. Gibbs A & Harrison B. 1976. Plant Virology - The Principles. Edward Arnold, London
9. Hull R. 2002. Mathews Plant Virology. 4th Ed. Academic Press, New York.
10. Verma JP. 1998. The Bacteria. Malhotra Publ. House, New Delhi.
11. Goto M. 1990. Fundamentals of Plant Bacteriology. Academic Press, New York.
12. Dhingra OD & Sinclair JB. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo.
13. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control. 3rd Ed. Oxford & IBH, New Delhi.
14. Vyas SC. 1993. Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill,New Delhi.
15. Rajeev K & Mukherjee RC. 1996. Role of Plant Quarantine in IPM. Aditya Books.
16. Rhower GG. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press

PATH 271
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

Course Outlines

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 upto 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 Qurantine, 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 upto generic level with the helpof 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.

Lecture Outlines

Theory

1. Introduction, definition of nematode, habitat (free living, parasitic nematodes) and diversity. Economic importance of nematodes in agriculture.
2. History of phytonematology - ancient, early and modern history of nematology. Contributions of N.A. Cobb, landmarks in history of nematology. Development of nematology in India.
3. General characteristics of plant pathogenic nematodes - Shape, size, body regions, segmentation, cuticle, body wall, symmetry, Nervous system
4. General morphology of nematodes - Stylets, inner body tube (digestive system), oesophagus parts and associated glands.
5. General morphology of nematodes - Reproductive system of male and female nematodes, excretory system
6. Biology - life cycle of nematodes, embryogenesis, hatching, moulting, host finding, host feeding and reproduction.
7. Nematode taxonomy - phylum Nematoda - Classes Adenophorea and Secernentea, Orders: Dorylaimida and Tylenchida, Aphelenchida.

8. Classification of nematodes based on feeding and parasitic habitat (Below and above ground parts). Pathological interactions of nematodes with other organisms - Fungi, Bacteria and viruses.
9. Nematode pests of crops - Rice -white tip nematode - *Aphelenchoides sp.* Rice root nematode - *Hirschmanniella sp.* Ufra disease - *Ditylenchus sp.*
10. Nematode pests of crops - Wheat - Wheat gall nematode - *Anguina sp.* Cereal cyst nematode - *Heterodera sp.* Molya disease - *Heterodera avenae;* Vegetables - Root knot nematode - *Meloidogyne sp.,* Cyst nematode - *Globodera sp.*
11. Nematode pests of pulses, oil seeds and fibre crops – Onion bulb and stem nematode - *Ditylenchus sp.,* Sting Nematode - B*eloinolaimus sp.,* Pea (early yellowing nematode) - *Rotylenchus sp.*
12. Nematode pests of perennial crops - Citrus - *Tylenchulus semipenetrans, Pratylenchus sp.;* Banana - Burrowing nematode - *Radopholus similis;* Tea, Coffee and Coconut - *Radopholus sp. Rotylenchus sp.* Palm red ring nematode - *Bursa phelenchus sp.*
13. Nematode management - cultural and physical methods
14. Nematode management - chemical methods *(fumigants and non-fumigants)*, Biological methods *(Paecilomyces, Pasteuria, Trichoderma, Pseudomonas, Azotobacter and Gluconobacter)*, VAM fungi.
15. Nematode management - Regulatory methods - Quarantine; Plant resistance, Integrated nematode management *Meloidogyne*
16. Entomopathogenic nematodes and their mode of action, significance of Entomopathogenic nematodes in biological control

Practicals

1 Apparatus and equipment used in Nematology laboratory
2&3 Sampling methods for nematode extraction, collection of soil and plant sam ples
4 Extraction of nematodes from soil following Cobb's sieving and decanting tech nique and Baermann funnel technique
5 Extraction of nematodes from plant tissues - Baermann funnel technique
6 Picking and mounting of plant parasitic nematodes
7 Counting of plant parasitic nematodes
8 Direct examination of infected roots by staining
9 Study of symptoms caused by important nematode pests of cereals
10 Study of symptoms caused by important nematode pests of vegetables
11 Study of symptoms caused by important nematode pests of pulses
12 Study of symptoms caused by important nematode pests of plantation crops
13 Identification of economically important plant parasitic nematodes up to ge neric level with the help of keys and description- *Meloidogyne*
14 Identification of economically important plant parasitic nematodes up to ge neric level with the help of keys and description- *Pratylenchus* and *Tylenchulus sp.*
15 Identification of economically important plant parasitic nematodes up to ge neric level with the help of keys and description- *Heterodera sp. Xiphinema sp. and Helicotylenchus sp.*
16 Methods of application of nematicides and organic amendments

Suggested readings

1. Webster J.M., 1972, Economic Nematology, Academic Press,Cambridge, Massachu-

setts
2. Zukerman, B.M., Mai, W.F. and Rohde, R.A., 1971. Plant Parasitic Nematodes, Academic Press, Cambridge, Massachusetts
3. Gopal Swarup, Dasgupta, D. R., Koshy, P. K. 1986, Plant Parasitic Nematodes of India: Problems and Progress, Indian Agricultural Research Institute, New Delhi
4. Walia R.K. and Bajaj H.K., 2014, Text book on Introductory, Plant Nematology - ICAR, New Delhi.

PATH 371
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

Course Outlines

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); Blackgram, Greengram (web blight, Cercospora leaf spot, anthracnose, yellow mosaic) and Redgram *(Phytophthora blight, fusarium wilt, sterility 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, blackarm). 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 mildew of cucurbits, Rhizoctonia and Cercospora leaf spot of greengram / blackgram, 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 field and 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.

Lecture outlines

Theory

1. Rice diseases - blast, brown spot, sheath blight, sheath rot, false smut,
2. Rice diseases (continued): bacterial leaf blight, Bacterial leaf streak, tungro and Khaira.
3. Wheat: Rusts, loose smut, Karnal bunt
4. Maize: Banded leaf and sheath blight, northern and southern corn leaf blight, downy mildew
5. Sorghum: anthracnose, charcoal rot, Smuts, grain mold Bajra : Downy mildew and ergot
6. Finger millet: Blast and leaf spot *(Helminthosporium and Cercospora)*
7. Groundnut: Early and late leaf spots, Sclerotium wilt, rust, Kalahasti malady
8. Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot, mosaic
9. Sunflower: Sclerotinia stem rot and Alternaria blight; Sesamum - *Alternaria* leaf-spot, Phyllody
10. Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot
11. Redgram: Phytophthora seedling blight, Fusarium wilt, Sterility mosaic
12. Blackgram, greengram: Cercospora leaf spot, anthracnose, web blight and yellow mosaic
13. Gram (Chickpea): Ascochyta blight wilt, grey mold Pea: Downy mildew, powdery mildew, rust
14. Sugarcane: Red rot, whip smut, ring spot, Pokkah Boeng, grassy shoot, ratoon stunting
15. Cotton: Anthracnose, vascular wilt (Fusarium & Verticillium) and black arm
16. Citrus : Canker, Gummosis, Tristeza and Greening
17. Mango: Anthracnose, Powdery mildew, Malformation, Bacterial blight
18. Banana: Sigatoka, Panama wilt, Bacterial wilt, Bunchy top
19. Grapevine: Downy mildew, Powdery mildew, Anthracnose
20. Apple: Scab, Powdery mildew, Fire blight, Crown gall
21. Guava: Wilt, Anthracnose, Pomegranate: Bacterial blight
22. Papaya: Foot rot, Leaf curl, mosaic Peach: leaf curl Strawberry: Cercospora Leaf spot
23. Coconut: Ganoderma Wilt, Bud rot, basal stem Rot, Tatipaka disease
24. Tea: Blister blight, Coffee: Rust
25. Potato: Early and late blight, Black scurf, Leaf roll, Mosaic
26. Tomato: Damping off, Early and late blight, Bacterial Wilt, Leaf curl, Mosaic, Tomato

spotted wilt virus
27. Brinjal: Phomopsis blight and fruit rot, Sclerotinia blight
28. Chillies: Anthracnose (die back and fruit rot), Alternaria leaf spot, Sclerotium Wilt, Choanephora blight, Leaf curl
29. Cucurbits: Downy mildew, Powdery mildew, Bacterial Wilt Crucifers: Alternaria leaf spot, Black rot, cauliflower mosaic
30. Beans: Anthracnose, Bacterial blight, rust Bhendi: Powdery mildew, Cercoapora leaf spot, Yellow vein mosaic virus
31. Ginger: Rhizome rot, Phyllosticta leaf spot Turmeric leaf spot, leaf blotch, Coriander stem gall
32. Rose: Die back, Powdery mildew, Black leaf spot Marigold: Botrytis blight, Cercospora leaf spot, Septoria blotch

Practicals

1. Field visit, collection and preservation of plant diseased specimens for herbarium.
2. Study of symptoms of rice blast, brown spot, sheath blight and bacterial blight
3. Study of symptoms of downy mildew and powdery mildew of cucurbits
4. Field visit, collection and preservation of plant diseased specimens for herbarium.
5. Study of symptoms of Rhizoctonia and Cercospora leaf spot of blackgram and greengram
6. Study of symptoms of Alternaria blight and downy mildew of mustard
7. Field visit, collection and preservation of plant diseased specimens for herbarium.
8. Study of symptoms of early blight and late blight of tomato and potato
9. Study of symptoms of Phomopsis blight of brinjalPowdery and rust of pea
10. Field visit, collection and preservation of plant diseased specimens for herbarium.
11. Study of symptoms of stem gall of coriander Anthracnose and fruit rot of chillies
12. Study of symptoms of leaf spot and leaf bloth of turmeric Red rot of sugarcane
13. Acquaintance with fungicides and their use for management of diseases in field and horticultural crops
14. Acquaintance with antibiotics and biopesticides for management of diseases in field and horticultural crops
15. Identification and histopathological studies of selected diseases of field crops
16. Identification and histopathological studies of selected diseases of horticultural crops

Suggested readings

1. R. S. Singh. (2017) . Plant Diseases. 10thRevised Edition, MedTech Publishers
2. Chaube, H. (2018). Plant Disease Management: Principles and Practices. CRC Press, Milton
3. R.C. Sharma, J.N. Sharma. 2011.Integrated Plant Disease Management. Scientific Publishers, India,
4. Agrios, GN. 2005. Plant Pathology. Elsevier Academic Press, Amsterdam

PATH 372
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

Course Outlines

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: Plasmids, episomes, and genetically modified organisms. 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

Practicals

Study of the microscope, Acquaintance with laboratory material and equipments, 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.

Lecture Outlines

Theory

1. Introduction to Microbiology: Definition, Applied areas of Microbiology and importance of Microbiology: Food & Dairy, Industrial products, Genetic engineering & Biotechnology, Environmental Microbiology, Medical Microbiology, Agriculture, Climate change and Computer applications.

2. History of Microbiology: Discovery of microorganisms; spontaneous generation theory, Germ theory of diseases, Immunization, fermentation and origin of life.
3. Bacteria: cell structure - External and internal structures of bacteria.
4. Photo autotrophy: Oxygenic photosynthesis (Cyclic photophosphorylation & Non-cyclic photophosphorylation)- Anoxygenic photosynthesis.
5. Chemoautotrophy: Nitrifying bacteria- Sulphur oxidizing bacteria- Iron oxidizing bacteria - Hydrogen oxidizing bacteria.
6. Growth: Growth cycle of bacteria- Synchronous growth-Diauxic growth- Generation time- Growth rate-Growth yield.
7. Bacterial genetics: Genetic recombination- Transformation, conjugation and transduction, Genetic engineering: Plasmids and Vectors - Ti plasmid, E.coli
8. Soil Microbiology: Nutrient mineralization and transformation- Nitrogen cycle, Phosphorous and Sulphur cycle.
9. Concepts of rhizosphere Microbiology- Rhizodeposits - Biochemical nature, release mechanism in rhizosphere, function, Carbon flow in rhizosphere, Rhizosphere microbiome residents and their roles in Agriculture (VAM, BNF, PSB)
10. Air Microbiology: Phyllosphere microflora, Phylloplane microflora, Microflora of floral parts etc.
11. Mechanisms of plant growth promoting rhizobacteria (PGPR) and endophytes on soil health and sustainability.
12. Food Microbiology: Microbial spoilage - Principles of food preservations, Food poisoning- Food borne infection *(E. coli, Salmonella sp., Listeria sp.,), Bacillus cereus, Clostridium perfringens, Clostridium botulinum)*- Food born intoxication *(Staphylococcus aureus, Bacillus cereus, Clostridium perfringens, Clostridium botulinum).*
13. Water Microbiology: Types of water, water microorganisms, and microbial analysis of water (coliform test), Purification of water.
14. Industrial Microbiology: Microbial products (organic acids, amino acids, vitamins, solvents, alcohol & alcoholic beverages, enzymes, steroid transformation, Single cell protein, antibiotics, biofertilizers, bioinsecticides) Biodegradation (Biogas production), Biodegradable plastics etc.
15. Biological control: Microbial biopesticides for plant disease management. Mode of action of EPF, NPV, Bacillus, EPNs, Mechanisms of *Trichoderma, Pseudomonas, Bacillus subtilis*
16. Bioremediation of polluted soils using microbial mediators: Types of Bioremediation- Phytore- mediation of polluted soils - Mechanism of phytoremediation- Advantages and Disadvantages.

Practicals

1. Direct Staining of bacteria by Crystal Violet and indirect/negative staining of bacteria by nigrosin
2. Gram Staining of bacteria
3. Microscopic observation of different groups of microorganisms (Bacteria, Fungi, Yeast)
4. Measurement of microorganisms using Stage micrometer and Haemocytometer
5. Preparation and Sterilization of culture media
6. Methods of microbial purification in vitro
7. Enumeration of microbal population in soil
8. Isolation and study of Rhizospheric microbes

9. Isolation and purification of N Solubilizers- PSB, KSB, ZSB
10. Isolation and purification of N-fixers-Rhizobium, Azotobacter, Azospirillum
11. Isolation and study of phyllosphere microorganisms
12. Isolation of endophytes
13. Preservation methods of microbial cultures
14. Isolation of VAM fungi by wet sieving and decantation technique
15. Enumeration of microbial population in food samples
16. Enumeration of microbes from water samples

Suggested readings

1. Pelczar, M.J., Chan, E.C.S. &Kreig, N.R. (2002) Microbiology. 5th Edition, Tata Mc-Graw-Hill, New Delhi.
2. Rangaswami, G. &Bagyaraj, D. J. (2005) Agricultural Microbiology. Prentice-Hall of India Pvt. Ltd New Delhi.
3. Mukherjee, N. & 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., & 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

SEC II

PRODUCTION TECHNOLOGY OF BIO-AGENTS

2 (0+2)

Lecture Outlines

Practicals

1. PATH-Acquaintance with Biocontrol Laboratory (Research & Commercial), Rearing rooms, Laboratory Instruments & Equipment used for the production of Bio agents
2. PATH-Importance, scope and potential of bioagents
3. PATH-Terms and Concepts- definition of Biocontrol (baker and Cook), Mechanisms Biological Control - Competition, Antibiosis and Hyperparasitism; PGPR, Endophytes, Phylloplane, Phyllosphere, Rhizoplane, Rhizosphere, Resistance, SAR, ISR and microbial consortia
4. PATH-Preparation of culture media for isolation of fungal and bacterial bioagents
5. PATH-Isolation & Characterization of *Trichoderma spp.*
6. PATH-Isolation & Characterization of *Pseudomonas fluorescence*
7. PATH-Isolation & Characterization of *Bacillus subtilis and Bacillus thuringiensis*
8. PATH-Isolation & Characterization of *Actinobacteria (Streptomyces spp. etc.)*
9. ENTO-Field visit to explore naturally infected cadavers of *Bt and Entomopathogenic fungi*
10. ENTO-Isolation & Characterization of *Beauveria bassiana*
11. ENTO-Isolation & Characterization of *Metarhizium anisopliae and Metarhizium rileyi*
12. ENTO-Isolation & Characterization of Entomopathogenic nematodes (EPNs)
13. ENTO-Isolation & Characterization of Entomopathogenic viruses from infected cadavers
14. PATH-Evaluating the efficacy of bioagents by different methods

15. PATH-Mass production of Fungal bioagents
16. PATH-Mass production of Bacterial bioagents
17. ENTO-Identification of Natural Enemies *(Parasitoids and Predators)*; Types of parasitism & Predation
18. ENTO-Mass Production Technology of predators like Coccinellids viz., *Cryptolaemus montrouzieri & Coccinella spp.*
19. ENTO-Mass Production Technology of Corcyra cephalonica, a factitious host for rearing of parasitoids and predators.
20. ENTO-Mass Production Technology of egg parasitoid, viz., *Trichogramma spp.*
21. ENTO-Mass multiplication of insect hosts like Spodoptera litura and Helicoverpaarmigera on specific semi- synthetic diet
22. ENTO-Mass production technologies of SlNPV&HaNPV
23. ENTO-Mass Production Greater wax moth, *Galleria mellonella*, a factitious host for rearing of EPNs.
24. ENTO-In-vivo mass production of Entomopathogenic Nematodes (EPNs)
25. ENTO-Laboratory bio-assay of EPBs, EPFs, NPVs & EPNs on their respective or selected host insects
26. PATH-Field evaluation for the efficacy of fungal and bacterial bio-agents against plant pathogens
27. ENTO-Field evaluation for the efficacy of Entomopathogenic fungal and bacterial bio-agents against insect pests.
28. PATH-Various Carriers used in bioagent commercial formulations
29. PATH-Quality control of bioagent formulations (both solid and liquid based); acquaintance with commercial formulations of bioagents
30. PATH-Application methods - Seed treatment, Seed pelleting, Seedling dip, sett treatment, Soil application (multiplication in FYM) and Foliar application
31. PATH-Impediments or limitations in mass production and use of bioagents
32. PATH-Visit to Biocontrol Laboratory

Suggested Readings

1. BS Parmar and C. Deva Kumar 1993.Botanical and Bio pesticides. West Will Publishing House, New Delhi pp 199
2. Srivastava, K. P. and Dhaliwal, G.S 2015. Applied Entomology.Vol I &II ,Kalyani Publishers, New Delhi
3. Sharma, P 2014. Biological Control of Plant Diseases and Weeds. Indian Council of Agricultural Research, New Delhi
4. Chincholkar, S.B. and Mukerji, K.G 2007. Biological Control of Plant Diseases. CRC Press, London

SEC IV
MUSHROOM PRODUCTION
2 (0+2)

Lecture Outlines

Practicals

1&2 Current status and scope of mushroom cultivation in India and Andhra Pradesh and nutritional benefits of mushrooms

3 Important features of edible fungi and study of basidiocarp

4	Acquaintance with the laboratory equipment and tools used in mushroom cultivation
5	Spawn Production technology (Milky/Oyster Mushrooms)- Preparation of culture media for the isolation fungal cultures
6	Spawn production technology -Isolation and purification of mushroom cultures
7	Spawn production technology -Maintenance of mother cultures and their preservation
8&9	Spawn production technology -Preparation of mother spawn
10	Spawn production technology -Preparation of commercial spawn
11	Design and economics of commercial spawn production unit
12	Exposure visit to Mushroom production units
13-16	Cultivation technology of Milky mushrooms *(Calocybe indica)* - Preparation of substrate and beds, crop management practices and casing preparation
17	Identification of pests and diseases of milky mushrooms and their manage ment
18-20	Cultivation technology of Oyster mushroom -Preparation of substrate and beds, crop management practices.
21	Identification of pests and diseases of Oystermushrooms and their manage ment
22	Mushroom farm design and infrastructure required for commercial unit
23	Harvesting, storage and packaging requirements of mushrooms
24	Preparation of value added products from mushrooms
25	Marketing of mushrooms and their value added products
26	Economic analysis of mushroom cultivation enterprise
27	Management of waste derived from Mushroom cultivation
28&29	Exposure on cultivation technology of *Agaricus bisporus* (button mushroom) - Compost preparation & Crop management aspects
30	Exposure on cultivation technology of *Lentinus edodes* (Shiitake) and *Volvari ella volvacea* (Paddy straw) mushrooms
31	Exposure on Cultivation technology of medicinal mushrooms - Ganoderma lucidum and Cordyceps militaris
32	Exposure visit to commercial mushroom farm units

Suggested Readings

1. ICAR- Directorate of Mushroom Research, Solan, Himachal Pradesh https://dmrsolan.icar.gov.in/
2. ICAR-Indian Institute of Horticultural Research, Bangalore, Karantaka. https://www.iihr.res.in/
3. Suman, B.C. and Sharma, V.P., 2007, Mushroom Cultivation in India, Daya Publishing House, Delhi
4. Santosh K. and Gireesh C. 2022, Techniques Of Mushroom Cultivation, Daya Publishing House, Delhi.
5. Paul Stamets and J.S. Chilton, 1985, The Mushroom Cultivator, Richmond Publishing Co Ltd, United Kingdom
6. Sharma, V.P and Suman, B.C, 2017, Diseases And Pests Of Mushrooms, Agrobios publishers, Jodhpur, Rajasthan

ELCT 471
AGROCHEMICALS
4 (3+1)

Objectives

1. To impart knowledge on different classes of agrochemicals

Course Outlines

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 copperoxy chloride. 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, Ogranophosphates, Carbamates, Synthetic pyrethriods Neonicotinoids, Biorationals. Insecticide Act and rules, Insecticides banned, withdrawn andrestricted 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 micro nutrient mixtures. Complex fertilizers: Manufacturingof ammonium phosphates, nitrophosphates and NPK complexes. Fertilizer control order. Fertilizerlogistic and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellent.

Practical

Sampling of fertilizers and pesticides. Pesticides application technology to study about variouspesticides appliances. Quick tests for identification of common fertilizers. Identification of anionand cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available K_2On market. Estimation of nitrogen in Urea. Estimation of water soluble P_2O_5 and citrate soluble P_2O_5 in single super phosphate. Estimation of potassiumin Murate of Potash/ Sulphate of Potash by flame photometer. Determination of copper content incopper oxychloride. Determination of sulphur content in sulphur fungicide.

Lecture Outlines

Theory

1. PATH-An introduction to agrochemicals, their type and role in agriculture
2. PATH-Effect of agro chemicals on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture
3. AGRO-Herbicides- Definitions- Advantages and limitations of herbicide usage in

India and Andhra Pradesh
4. AGRO-Classification of herbicides based on chemical nature, time and method of application
5. AGRO-Herbicides- Major classes, properties of important herbicides
6. AGRO-Fate of foliar and soil applied herbicides
7. PATH-Classification of fungicides based on application methodology and usage
8. PATH-Classification of fungicides based on mode of action and chemical nature
9. PATH-Characteristics and use of Copper fungicides - Preparatory and Proprietary fungicides
10. PATH-Characteristics and use of - sulphur fungicides - inorganic sulphur fungicides (preparatory and proprietary)
11. PATH-Characteristics and use of - sulphur fungicides (dithiocarbamates) - Organic sulphur fungicides (mono alkyl and dialkyl dithio carabamates) - Other contact fungicides
12. PATH-Characteristics and use of Heterocyclic nitrogenous compounds
13. PATH-Characteristics and use of Miscellaneous fungicides
14. PATH-Characteristics and use of - Systemic fungicides - Acylalanines, benzimidazoles, thiophanates, carboxamides, triazoles - Their mode of action
15. PATH-Characteristics and use of - Systemic fungicides - Strobilurins, morpholines, organophosphates, oxathins - their mode of action
16. PATH-Characteristics and use of - Antibiotics - Antifungal and antibacterial antibiotics
17. PATH-Foliar Sprays and Dusts: Methods of application viz., spraying high, low and ultra low volume and dusting - Advantageous and disadvantageous of these methods.Seed treatment methods: Dry, wet and slurry, fungicides/bactericides used for seed treatment Soil treatment methods- Fumigation broadcasting, furrow application and soil drenching chemicals used for soil treatment.
18. PATH-Post Harvest Application, Use of fumigants, smokes, dusts, solutions, barriers and insulators to impede the spread of post harvest diseases of fruits and vegetables, chemicals, oils and botanicals used in post harvest disease management. Tree wound dressing- Procedure chemicals used and diseases controlled.
19. PATH-Disinfection of warehouses using various chemicals.
20. PATH-Development of Resistance in Plant Pathogens against Chemicals Meaning of terms resistance, tolerance and cross resistance. Mechanisms by which pathogens develop resistance to various fungicides and bactericides. Methods of management of resistance, gene pyramiding, gene deployment and use of multilines
21. PATH-Study on formulations of fungicides available in the market
22. PATH-Fungicide Resistance Action Committee (FRAC)
23. ENTO-Introduction and classification of insecticides: Inorganic and organic insecticides Inorganic insecticides - Arsenic Compounds - Fluorine and sulphur; Botanicals, Plant derived insecticides - Neem based products - Different commercial formulations containing azadirachtin, neem seed kernel extract, neem cake and their uses - Nicotine, rotenone, plumbagin and pyrethrum - Source - Properties and uses
24. ENTO-Organochlorines- Synthetic organic insecticides - Chlorinated hydrocarbons - Dichloro Diphenyl Trichloroethane (DDT), Dicofol and HexacholoroCyclo Hexane (HCH). Cyclodiens - Aldrin, dieldrin, heptachlor and endosulfan - Toxicity and mode of action

25. ENTO-Organo phosphates - Systemic, non-systemic and translaminar action of insecticides with examples - Brief mode of action - Toxicity, formulations and uses of malathion, dichlorvos, quinalphos, phosalone, chlorpyriphos, monocrotophos, methyl demeton, dimethoate, ethion, triazophos, profenophos, acephate and phorate
26. ENTO-Carbamates - Mode of action - Toxicity, formulations and uses of carbaryl, propoxur, carbofuran, fenobucarb, thiodicarb and methomyl
27. ENTO-Synthetic pyrethroids - Brief mode of action - Toxicity, formulations and uses of allethrin, resmethrin, bioresmethrin, bioallethrin, fenvalerate, permethrin, deltamethrin, cypermethrin, lambda cyhalothrin, cyfluthrin, fenpropathrin, flucythrinate, fluvalinate and fenfluthrin.
28. ENTO-Insecticides of other groups - Nicotinoid insecticides - Brief mode of action - Toxicity, formulations and uses of imidacloprid, acetamiprid, thiamethoxam, Thiacloprid, dinotefuran and clothianidin.
29. ENTO-Biorationals - Brief mode of action, toxicity, formulations and use - Phenyl pyrazoles, fipronil - Macro cyclic lactones - Spinosyns - Spinosad; Avermectins - Abamectin and emamectin benzoate; Oxadaizines - indoxacarb; Thioureas - Diafenthiuron; Pyridine azomethines - Pymetrozine; Pyrroles - Chlorfenapyr. Formamidines - Chlordimeform and Amitraz; Ketoenols - Spirotetramat, Spiromesifen and Spirodiclofen. Diamides - Chlorantraniliprole, Cyantraniliprole and Flubendiamide
30. ENTO-IGRs- Brief mode of action - Toxicity, formulations and use - Chitin synthesis inhibitors - Diflubenzuron, Flufenoxuron, Triflumuron, Teflubenzuron, Lufenuron, Novaluron, and Buprofezin; Juvenile hormone (JH) mimics - Juvabione, Methoprene, Hydroprene, Kinoprene, Pyriproxyfen and Fenoxycarb - Anti JH or Precocenes, Ecdysone agonists - Methoxyfenozide , Halofenozide and Tebufenozide.
31. ENTO-Biopesticides and reduced risk insecticides- Plant bio-pesticides for ecological agriculture, Botanicals,
32. ENTO-Repellents (Physical and Chemical) and antifeedants-Importance of antifeedants and limitations of their use
33. ENTO-Recent advances in pest control- Attractants-Sex pheromones-List of synthetic sex pheromones- Use in IPM-Insect hormones-Gamma irradiation-Genetic control-Sterile male technique.
34. ENTO-Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil and plant - Botanicals, plant and animal systemic insecticides their characteristics and uses.
35. SSAC-Fertilizers and their importance-classification with examples-nitrogenous fertilizers- feed stocks- manufacturing process and properties of ammonium sulphate, ammonium nitrate, CAN
36. SSAC-Manufacturing process and properties of ammonium chloride and urea-slow release nitrogenous fertilizers
37. SSAC-Phosphatic fertilizers- uses- types and properties - manufacturing process and properties of SSP, TSP, bone meal and basic slag
38. SSAC-Potassic fertilizers- Natural sources- Manufacturing process and properties of Muriate of Potash, sulphate of potash and potassium nitrate-mode of action of N,P and K in soils or reactions of fertilizers in soil
39. SSAC-Secondary and micronutrient fertilizers- Different sources of nutrients and their contents- Conditions leading to their deficiency

40. SSAC-Nano-fertilizers - Water soluble fertilizers- Customized fertilizers - Fertilizer grade - Fertilizer ratio - unit value of fertilizers
41. SSAC-Soil amendments - Different types of amendments- Role of important organic and inorganic amendments and synthetic conditioners as amendments
42. SSAC-Mixed and complex fertilizers - Sources- Advantages and disadvantages over straight fertilizers- Compatibility of fertilizers- Physical problems and chemical problems associated with bulk blended fertilizers- Problems on formulation of fertilizer mixtures
43. SSAC-Manufacturing process and properties of ammonium phosphate, urea ammonium phosphate(UAP), ammonium sulphate nitrate and ammonium poly phosphates- Nitrate phosphates and NPK complexes
44. SSAC-Fertilizer storage- Introduction - Common problems during storage- Caking - Dustiness - Chemical compatibility - Corrosivity
45. SSAC-Physical and chemical properties of fertilizers affected during storage- Relative humidity (CRH)- Particle size distribution- Moisture content- Free acidity- Bulk density- Particle hardness and hygroscopicity- Storage and handling properties of some common fertilizers
46. SSAC-Fertilizer control Order (FCO) - importance and regulations - Specifications and fertilizer storage standards of important fertilizers
47. SSAC-Fertilizer logistics and marketing- Introduction - Organisational setup and functions- Development and growth of fertilizer industry- Movement of major fertilizers
48. SSAC-Measures of support for fertilizer sector - Public sector- Undertakings - Fertilizer monitoring system- vigilance activities.

Practicals

1. PATH-Sampling of fertilizers and pesticides (Insecticides / fungicides / herbicides)
2. AGRO-Study and identification of various fertilizers and formulations of herbicides available in market and calculation of doses of fertilizers and herbicides
3. PATH-Preparation of Bordeaux mixture, Bordeaux Paste, Burgundy mixture and Cheshunt compound
4. PATH-Preparation of Lime sulphur
5. PATH-Acquaintance with contact fungicides- Calculation of dosage of fungicides
6. PATH-Acquaintance with Systemic fungicides - Calculation of dosage of fungicides
7. ENTO-Study and identification of various formulations of insecticides available in market
8. ENTO-Calculation of doses of insecticides
9. PATH-Pesticides application technology to study about various pesticides appliances.
10. SSAC-Quick tests for identification of common fertilizers
11. SSAC-Identification of anions and cations in unknown fertilizer
12. SSAC-Estimation of nitrogen in Urea
13. SSAC-Estimation of watersoluble P_2O_5 and citrate soluble P_2O_5 in single Super Phosphate by Pemberton's method
14. SSAC-Estimation of potassium in MOP/SOP by flame photometer method
15. PATH-Determination of copper content in Copper Oxychloride
16. PATH-Determination of sulphur content in Sulphur fungicide (elemental sulphur)

Suggested Reading

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.
6. Mehrotra R.S. 1980. Plant Pathology. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
7. Nene Y.L. and Thapliyal P N 1993. Fungicides in Plant Disease control. Oxford & IBH publishing Co., New Delhi
8. Vyas S C 1993. Hand Book of systemic Fungicides. Tata McGraw Hill, Vol. I, II and III, publishing Co. Ltd., New Delhi
9. HCL Gupta. 1999. Insecticides Toxicology and Uses. Agrotech Publishing Academy, Udaipur.
10. Larramendy, M.L. 2017. Toxicity and Hazard of Agrochemicals, INTECH, 170p.
11. 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
12. S Sriramulu 1979. Methods of Pesticide analysis. Oxford IBH, New Delhi
13. Singh, A. 2022. Basics of Agrochemical Formulations, Brillion Publishing, 176p.
14. Srivastava R P and Saxena R C 2020. A text book of Insect toxicology. Himanshu Publications, Udaipur
15. Vasantharaj David, B and Aanathakrishnan, T.N.. 2006. General and Applied Entomology. Tata McGraw- Hill Publishing House, New Delhi.
16. Vasantharaj David, B and Ramamurthy V V. 2016. Elements of Economic Entomology. Np Namuratha Publications, Chennai.

HORTICULTURE

HORT 181
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

Course Outlines

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 horti -cultural 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.

Lecture Outlines

Theory

1. Horticulture- Definition- Divisions of horticulture with suitable examples
2. Scope and Importance of horticulture - Importance of horticulture in terms of income, employment generation, industry, religious, aesthetic, food & nutritive value and export
3. Horticultural botanical classification - Nature and continuation of growth - Types of fruit - Plant part used- Ripening - Ethylene evolution - Bearing habit
4. Horticultural classification based on soil, salinity, acidity - Climate - Temperature and photoperiod
5. Climate and soil for horticultural crops - Influence of environmental factors on horti cultural crop production - Temperature, humidity, wind, rainfall and solar radiation - Influence of soil factors - Soil type, pH, EC
6. Propagating structures - Mist chamber, green house, lath house, hot bed, cold bed
7. Plant propagation - Definition - Sexual and asexual - Merits and demerits
8. Seed dormancy - Definition and types - Seed germination - Polyembryony
9. Plant propagation by stem and root cuttings - Definition of cutting - Types of stem

cuttings - Leaf cuttings root cuttings

10. Propagation by Layering- types of layering - Tip, simple, compound, mound, trench, air layering
11. Propagation by natural modifications of layering (runners, suckers, stolon, offset)
12. Propagation by Separation-bulbs, corms; division (rhizome, stem tuber, tuberous roots)
13. Grafting- Rootstock and scion selection - Grafting methods- attached scion methods of grafting, simple or approach grafting, detached scion methods of grafting (side grafting- veneer grafting; apical grafting- epicotyl grafting, double, soft wood grafting, cleft grafting, tongue grafting, whip grafting)
14. Graft incompatibility - Types - Translocated and localized incompatibility; Top working
15. Budding - Methods of budding - T-budding, inverted T-budding, patch budding and ring budding.
16. Principles of Orchard establishment - Site selection for the establishment of orchards
17. Steps in orchard establishment - Layout of orchards
18. Systems of planting - Square, rectangle, quincunx, hexagonal and contour systems of planting-their merits and demerits
19. High Density Planting - Components (dwarf scions, rootstocks, training and pruning, use of growth regulators) - Advantages and disadvantages
20. Principles and methods of training - Definition of training, objectives and training - Methods of training in fruit crops-open centre, closed centre and modified leader systems their merits and demerits
21. Principles and methods of pruning - Definition of pruning, objectives of pruning, methods of pruning in horticultural crops
22. Juvenility and Methods for shortening juvenility - Application of growth regulators (Gibberellins, Auxins, Cytokinins, Abscissic acid, Ethylene), environmental methods (photoperiod, temperature), Cultivation techniques (grafting, pruning, girdling, irrigation, nutrition)
23. Flower bud differentiation - Bearing habit - types of bearing habits in horticultural crops
24. Unfruitfulness - Definition - Factors - Physiological, phylogenical, management, parasitical, climatological factors
25. Pollination - Factors for Self and Cross pollination, pollinizers and pollinators
26. Fertilization and Parthenocarpy-Definition and its types
27. Vegetable gardens - Types - Kitchen Garden, Market garden, Truck Garden, Vegetable Forcing, Garden for Processing, Seed production garden and Floating Garden.
28. Ornamental garden types - Formal - Informal - Wild Garden - Parts/features of an ornamental garden
29. Lawn making - Suitable Grasses - Methods of planting - Sowing of Seeds - Dibbling - Turfing - Turf plastering - Maintenance of lawn - Weeding - Liming – Rolling - Mowing - Sweeping –Scraping - Raking - Irrigation - Management of pests & diseases.
30. Irrigation methods in horticulture crops - Different methods followed in horticultural crops (flood, basin, check basin, ring basin, furrow, pitcher, funnel, drip, sprinkler, bubbler etc.)
31. Fertilizer application- Different methods of application to horticultural crops-

Broad casting, top dressing, localized placement, contact placement Band placement, row placement, pellet, foliar application, starter solution, fertigation.

32. Importance of plant bio-regulators (PBR) in horticulture - Introduction - Applications of PBR in fruit crops

Practicals

1. Identification of tools and implements
2. Identification and nomenclature of horticultural crops
3. Layout of an orchard, pit making and system of planting
4. Nursery raising techniques of fruit crops
5. Propagation through seeds
6. Propagation through cuttings and divisions
7. Propagation through grafting
8. Propagation through budding
9. Propagation through layering
10. Containers, potting mixture, potting and repotting
11. Training and pruning methods on fruit crops
12. Preparation of fertilizer mixture and application
13. Preparation and application of PGR
14. Layout of different irrigation systems
15. Maturity studies of horticultural crops
16. Visit to commercial nurseries/ orchards

Suggested Readings

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

HORT 281
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

Course Outlines

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, 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, aftercare, 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 and oilpalm, Plantation crops: cashew, tea, coffee, cocoa and rubber

Practical

Propagation techniques, selection of planting material, varieties, important cultural practices for mango, banana, papaya, guava, 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, Visit to commercial orchard and plantation industries.

Lecture outlines

Theory

1. Scope and Importance of fruit and plantation crops - Nutritional, industrial and medicinal importance - Classification of fruit crops - Area, production and export import trade of fruit and plantation crops
2. Mango - Importance - Climate - Soil - Varieties - Propagation and use of root stocks - Planting density and systems of planting - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Value addition - Physiological disorders
3. Banana - Importance - Climate - Soil - Varieties - Propagation - Planting density and systems of planting - Water, nutrient and weed management - Inter cultivation - Special intercultural operations - Maturity indices and harvest - Value addition - Physiological disorders
4. Citrus - Importance - Climate - Soil - Varieties - Propagation and use of root stocks - Planting density and systems of planting - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Value addition - Physiological disorders
5. Guava and Litchi - Importance - Climate - Soil - Varieties - Propagation and use of root stocks - Planting density and systems of planting - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Value addition - Physiological disorders
6. Papaya and Pomegranate - Importance - Climate - Soil - Varieties - Propagation and use of rootstocks - Planting density and systems of planting - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Value addition- Physiological disorders
7. Grape - Importance - Climate - Soil - Varieties - Propagation and use of root stocks - Planting density and systems of planting - Training and pruning - Water, nutrient

and weed management - Inter cultivation - Maturity indices and harvest - Value addition - Physiological disorders

8. Pineapple, Jack fruit and Ber - Importance - Climate – Soil - Varieties - Propagation and use of root stocks - Planting density and systems of planting - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Value addition
9. Apple and Strawberry - Importance - Climate - Soil - Varieties - Propagation and use of root stocks - Planting density and systems of planting - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Value addition - Physiological disorders
10. Coconut and Arecanut-Importance - Climate - Soil - Varieties - Propagation - Nursery management - Planting density and Cropping systems - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition
11. Cashewnut - Importance - Climate - Soil - Varieties - Propagation - Nursery management - Planting density and Cropping systems - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition
12. Oil palm- Importance - Climate - Soil - Varieties - Propagation - Nursery management - Planting density and Cropping systems - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition
13. Tea - Importance - Climate - Soil - Varieties - Propagation – Nursery management - Planting density and Cropping systems - Shade management - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition
14. Coffee - Importance - Climate - Soil - Varieties - Propagation - Nursery management - Planting density and Cropping systems - Shade management - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition
15. Cocoa - Importance - Climate - Soil - Varieties - Nursery management - Planting density and Cropping systems - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition
16. Rubber - Importance - Climate - Soil - Varieties - Nursery management - Planting density and Cropping systems - Training and pruning - Water, nutrient and weed management - Inter cultivation - Maturity indices and harvest - Processing - Value addition

Practicals

1. Identification of fruit and plantation crops
2. Propagation methods for fruit crops
3. Propagation methods for plantation crops
4. Micro-propagation
5. Preparation of plant bio regulators and their uses
6. Coconut propagation - Mother palm selection, seed nut selection and raising of coconut seedlings
7. Pre-treatment of banana suckers and de-suckering in banana

8. Sex forms and latex extraction in papaya
9. Canopy management in fruit crops
10. Fertilizer scheduling in mango, banana, citrus and grape
11. Fertilizer scheduling in guava, papaya, strawberry and pomegranate
12. Fertilizer scheduling in coconut, cashewnut and oil palm
13. Physiological disorders of fruit crops - Mango, Citrus, Grape
14. Physiological disorders of plantation crops
15. Visit to processing unit
16. Visit to commercial plantations/ fruit orchards

Suggested Readings

1. Bose, T.K., S.K. Mitra and D. Sanyal 2001. Fruits: Tropical and Subtropical (2 volumes) Naya Udyog, Calcutta.
2. Chadha, K.L. 2001. Handbook of Horticulture. ICAR, Delhi
3. Chadha, T.R. 2001 Textbook of temperate fruits. ICAR, New Delhi
4. Chattopadhyay, T.K. 2001. A Text Book on Pomology (4 volumes). Kalyani Publishers, Ludhiana.
5. Das, B.C and Das, S.N. Cultivation of minor fruits. Kalyani Publishers, Ludhiana.
6. Kavino, M, V. Jegadeeswari, R. M. Vijayakumar and S. Balkrishnan. 2018. Production Technology of Fruits and Plantation Crops by Narendra Publishing House.
7. 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.
8. Sharma, A., Kumar, P., Tripathi, V.K. 2024. Production Technology of Fruits and Plantation Crops. Elite Publishing House.

HORT 282
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

Course Outlines

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, cucumber, bitter gourd , bottle gourd, water melon, muskmelon, 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, ginger, 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.

Lecture Outlines

Theory

1. Importance of vegetables & spices in human nutrition and national economy - Kitchen gardening
2. Tomato- Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield - physiological disorders
3. Brinjal& Chilli - Botanical Name - Family - Origin - Area - Climate and soil -Improved varieties and cultivation practices such as time of sowing - sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield
4. Okra & Leafy vegetables (Amaranthus & Palak) - Botanical Name - Family - Origin - Area - climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield
5. Cucurbits - Flowering, Sex expression, sex ratio; Cucumber, Bitter gourd, Bottle gourd, Watermelon and muskmelon - Botanical Name - Family - Origin - Area - Climate and soil - improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield
6. Cole crops- Cabbage, Cauliflower & Knol-khol -Botanical Name - Family - Origin - area - climate and soil - improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield - Physiological disorders
7. Peas and Beans - Garden pea & French bean - Botanical Name - Family - Origin - Area - climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield- Physiological disorders
8. Root crops (Carrot, Radish & Beetroot) - Botanical Name - Family - Origin - Area - climate and soil - improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield- Physiological disorders
9. Sweet potato & Potato - Botanical Name - Family - Origin - area - climate and soil - improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield- Physiological disorders
10. Perennial vegetables - Drumstick, Curry Leaf & Coccinia- Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices

such as time of Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield

11. Bulb crops - Onion & Garlic - Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - transplanting techniques - planting distance - fertilizer requirements - irrigation - weed management - harvesting and yield physiological disorders
12. Black pepper - Botanical Name - Family - Origin - Area - climate and soil - improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield- Processing
13. Cardamom - Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield - Processing
14. Ginger & Turmeric - Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield - Processing - Preservation of seed rhizomes
15. Coriander, Fenugreek & Mint - Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield
16. Cinnamon & Tamarind - Botanical Name - Family - Origin - Area - Climate and soil - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting and yield - Processing

Practicals

1. Identification of vegetables and their seeds
2. Identification of spices crops and their seeds
3. Varietal description of vegetables
4. Varietal description of Major spices
5. Propagation methods - Rapid multiplication techniques of pepper and cardamom
6. Nursery raising techniques of vegetable crops
7. Direct seed sowing and transplanting
8. Study of morphological characters of different vegetables
9. Study of morphological characters of different spices
10. Fertilizers application methods
11. Harvest indices and maturity standards of vegetable crops
12. Post-harvest handling of vegetables
13. Seed extraction methods in vegetables
14. Seed extraction methods in spices
15. Economics of vegetables and spices cultivation.
16. Visit to spice gardens/vegetable fields

Suggested Readings

1. Pranab Hazra, A. Chattopadhyay, K. Karmakar and S. Dutta. 2010. Modern technology in vegetable production. New India Publishing Agency, New Delhi.
2. Neeraj Pratap Singh, .2007. Basic Concepts of Vegetable Science. International Book

Distributing Co. New Delhi. Academic Press, New Delhi.
3. Nempal Singh, Singh, D.K., Singh, Y.K. and Virendra Kumar. 2006. Vegetable Seed Production Technology. International Book Distributing Co. Lucknow.
4. Prem Singh Arya and S. Prakash 2002. Vegetable growing in India. Kalyani publishers, New Delhi
5. Bose, T. K, Kabir, J., Maity T. K., Parthasarathy V. A., and Som M. G., 2002. Vegetable Crops Vol. II & III Naya Prokash, Kolkata.
6. Shanmugavelu, K.G., N. Kumar and K.V. Peter 2005. Production Technology of Spices and Plantation Crops. Agrobios (India), Jodhpur.
7. Singh, K.P. and Anant Bahadur. Olericulture, Fundamentals of Vegetable Production (Vol.1).
8. Fagaria, M.S. Choudhury, B.R. and Dhaka R.S.Vegetable crops (Production technology, Vol II). Kalyani Publishers. New Delhi.

SEC VIII
PLANTATION CROP PRODUCTION AND PROCESSING
2 (0+2)

Practicals

1. Identification of plantation crops
2. Description and identification of coconut and arecanut varieties
3. Description and identification of species and varieties in coffee
4. Description and identification of cashewnut and cacao varieties
5. Selection of mother palm, seed nuts and planting of seed nuts in the nursery of coconut and arecanut.
6. Seed treatment and nursery raising of oil palm
7. Layout and planting of palms
8. Propagation and nursery raising of cashewnut and cocoa
9. Layout and planting of cashewnut and cocoa
10. Epicotyl and softwood grafting in cashewnut
11. Rejuvenation techniques in cashewnut
12. Training and pruning in cashewnut and cocoa
13. Shade management in coffee
14. Propagation of tea and coffee
15. Training and pruning in tea and coffee
16. Pests and diseases of coconut and arecanut
17. Pests and diseases of cocoa, cashewnut and rubber
18. Pests and diseases of coffee and tea
19. Study of different by-products of plantation crops
20. Physiological disorders of plantation crops
21. Harvesting and processing of cacao
22. Harvesting and processing of cashewnut
23. Harvesting and processing of oil palm
24. Harvesting and processing of tea
25. Harvesting and processing of coffee
26. Different methods of tapping in rubber
27. Working out of economics and project preparation for coconut and arecanut

28. Working out of economics and project preparation for cacao and oil palm
29. Working out of economics and project preparation for cashewnut
30. Working out of economics and project preparation for tea and coffee
31. Visit to plantation nursery/ estate/ research station
32. Visit to commercial plantations and processing units

Suggested Readings

1. Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. Introduction to spices, Plantation crops and Aromatic plants. Oxford & IBH, New Delhi.
2. Nair 1979. Cashew. CPCRI, Kerala
3. Ranganadhan, V. 1979. Hand Book of Tea Cultivation. UPASI Tea Research Station, Cinchona.
4. Thampan, P.K. 1981.Hand Book of Coconut Palm. Oxford IBH, New Delhi.
5. Thompson, P.K. 1980. Coconut. Oxford & IBH Publishing Co. Ltd., New Delhi.
6. Wood, GAR, 1975. Cacao. Longmen, London

SEC XI
COMMERCIAL HORTICULTURE
2 (0+2)

Practicals

1. Importance of commercial Horticulture - Identification of horticultural crops
2. Tools and implements used for horticultural crops production
3. Preparation of nursery beds and sowing of seeds
4. Seed propagation- methods of breaking seed dormancy
5. Types of growing media used in raising nursery
6. Production of high value vegetables/flowers under protected cultivation
7. Containers used for growing of horticultural crops
8. Preparation of potting media- Potting and re-potting of ornamental crops
9. Pro-tray raising of seedlings
10. Propagation through cuttings (Stem, leaf and root)
11. Propagation through separations and divisions
12. Practicing the different methods of layering
13. Practicing methods of grafting in horticultural crops
14. Practicing methods of budding in horticultural crops
15. Hands on experience on making hanging pots/Ornamental crops
16. Practicing different methods of training in horticultural crops
17. Practicing different methods of pruning in horticultural crops
18. Irrigation management in horticultural crops
19. Weed management in horticultural crops
20. Nutrient management in horticultural crops
21. Vertical gardening
22. Roof gardening
23. Methods for dry flower making - hands on experience in making potpourri, skeletonization, garland etc.
24. Hands on experience in making carpet beds, flower beds, topiaries
25. Hands on experience in making terrarium
26. Study of different packaging material

27. Plant growth regulators in propagation - Preparation and practicing
28. Storage of propagation material - Bulbous/corms/rhizomatous horticultural crops
29. Styles of floral arrangements
30. Visit to commercial nurseries
31. Visit to commercial orchards
32. Visit to fruit, flower and vegetable market

Suggested Readings

1. Introduction to Horticulture - by Kumar N
2. Plant propagation- Principles and Practices by Hartmann and Kester
3. Floriculture and landscaping - G.S. Randhawa and Amitabha Mukhopadhyay

SEC XII
FLORICULTURE AND LANDSCAPING
2 (0+2)

Objectives

1. To train the learners on the Floriculture and Landscaping

Practicals

1. Identification of various types of flower plants.
2. Identification of ornamental trees and climbers.
3. Identification of tools and implements used in landscape design.
4. Study of ground covers and indoor plants.
5. Identification and production of plug plants, seedlings and saplings.
6. Propagation of trees, shrubs and annuals, care and maintenance of plants.
7. Potting and repotting
8. Practice of propagation through specialized structures - Cuttings and layering
9. Practice of propagation through specialized structures- Budding and grafting
10. Making and maintenance of edge, hedge and topiary.
11. Planning of ornamental gardens (public and private gardens).
12. Planning of special type of gardens (sunken garden, terrace garden, rock garden etc.,)
13. Identification of turf grasses and turf machinery.
14. Turf establishment methods.
15. Lawn maintenance – mowing, raking, rolling, soil top dressing, weed management.
16. Physiological disorders of flowers and their remedial measures.
17. Harvesting indices of flower crops.
18. Post harvest factors affecting postharvest quality of flowers.
19. Preparations of floral preservatives.
20. Post harvest handling of commercial flowers - Rose, Chrysanthemum, Gladiolus, Lilium, Tuberose and Marigold.
21. Use of drawing equipment, graphic symbols and notations in landscaping designing.
22. Designing of different styles of gardens.
23. Practices in preparation of different type of flower arrangements including bouquets, button-holes, flower baskets.
24. Practices in preparation of different type of flower arrangements including corsages, floral wreaths, garlands with fresh flowers.

25. Identification of plants for dry flower making.
26. Practices in dry flower making, preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.
27. Value addition of dry foliage.
28. Biproducts of flower crops - Rose water/ Gulkhand/ Pigments.
29. Visit to local nurseries.
30. Visit to commercial greenhouses.
31. Visit to parks and botanical gardens.
32. Visit to dry flower units/ florist centers.

Suggested Readings

1. Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
2. Chadha KL and Bhattacharjee SK. 1995. Advances in Horticulture: Ornamental Plants. Vol. XII, Parts 1 & 2. pp.533 and pp.574. Malhotra Publ. House, New Delhi, India.
3. Bose TK, Maiti RG, Dhua RS and Das P. 1999. Floriculture and Landscaping. Naya Prokash,Kolkata, India.
4. Jankiram, T, Namita and Jain Ritu. Introduction to Turf grasses. 2015. 1st edn. Westville publishing house.
5. Nick E. 2016. Christians Fundamentals of Turfgrass Management. 5th edn, Aaron J. Patton, Quincy D. Law. Published by Wiley.
6. Tyagi S and Sahay S 2020. Protected cultivation of flowers 2020 NIPA, New Delhi.
7. Gupta Sachi, Pathak Sanjay and Yadav Atul. 2019. Advances and value addition in flower crops. Weser Books.
8. Arora, J.S. 2010. Introductory Ornamental Horticulture. Kalyani Publishers. 6th edn, pp.230.
9. Randhawa, G. S. and Mukhopadhyay, A. 2001. Floriculture in India. Allied Publishers. pp 660.
10. Nowak, J and Rudnicki, RM. 1990. Post harvest handling and storage of cut flowers, florist greens, and potted plants. Timber Press, USA. pp. 210.

ELCT 481
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 software's like AUTOCAD, ARCHCADE etc.

Course Outlines

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.

Lecture Outlines

Theory

1. Importance and scope of landscaping - Goals of landscaping - Categories of landscaping: Residential, public, commercial, specialty landscaping.
2. Principles of landscaping: Initial approach, Axis, Focal Point, Mass effect, Unity, Space, Divisional Lines, Proportion and Scale, Texture, Time and Light, Tone and Colour, Mobility, Rhythm, Balance, Contrast, Harmony, Vista and Style.
3. Garden types: Formal gardens, Informal gardens and Wild Gardens.
4. Styles of garden - Mughal Garden: site and design - walls and gates - terrace - running water - baradari - trees and flowers.
5. English garden - Features; Italian garden - features; French garden - features; Persian Garden - features; Japanese Garden - Types of Japanese Garden: Hill, Flat, Tea, Passage and Sand Gardens.
6. Japanese Garden - features: Ponds, Streams, Waterfalls, Fountains, Islands, Bridges, Water Basins, Stone Lanterns, Stones, Pagodas, Fences and Gates, Veg etation (Ever green, Deciduous and Flowering plants).
7. Famous Gardens of India - Lal bagh (Bangalore), Brindavan Garden (Mysore), Government Botanic Gardens (Ootacamud), Mughal garden (Pinjore) and Chandigarh Rose garden.
8. Terrace gardening - Features - Plants suitable - Planning - Maintenance.
9. Vertical gardening - Components.
10&11. Garden components or features - Garden walls, Retaining wall, Fences and Gates, Hedges, Edges, Flower bed, Borders, Carpet Bedding, Topiary, Lily pool, Steps, Garden Drives (Gravel and Asphalt) and Paths (Gravel, Brick, Grass, Stone Crazy pavings).
12. Garden components or features - Arches, Pergolas, Screens, Bridges, Outdoor garden rooms (Gazebos, garden pavilions, band stand, bower and thatched huts) and walk-paths.
13&14. Garden adornments– Garden Seats, Ornamental tubs, urns and Vases, Bird baths, Sun dials, Floral Clocks, Japanese Lanterns, Ornamental Stones, Foun tains, statues, Wells, Plants Containers, Plant Strands.

15&16. Lawn making - Selection of Grass: Bermuda grass, Korean grass, Poa grass, Fescue grass and Kentucky blue grass - Grasses for shady areas; Site Selection: Soil, Preparation of soil, drainage, digging, manuring and grading; Methods of planting: Sowing of Seeds, Dibbling, Turfing, turf plastering, Bricking and Planting on Polythene.

17. Maintenance of lawn - Mowing, Rolling, Sweeping, Scraping, Raking, Weeding, Irrigation, Top dressing with compost and fertilizers - Diseases and other problems: Fairy ring and Pale Yellow Lawn.

18&19. Rock Garden (Rockery) - Types of rock Garden - Selection of site - Construc tion of the Rockery - Planting - Management of the Rockery - Plants for rock garden: Examples of Cacti and succulents, ferns, shrubs, herbaceous plants, bulbs, flowering annuals.

20&21. Water garden - Types: Informal pool and Formal Pool; Construction - Planting methods - Filling the pool (water course and falls) - Care of the water garden - Plants for water garden: Surface flowering aquatics, Oxygenators, Floaters and Marginals.

22&23. Gardens for special purposes: Herb garden, Bog Garden, Sunken garden, Topi ary Garden, Kitchen garden, Paved garden, Moon Garden, Gardening in hang ing baskets, Window garden, Miniature garden, Mini Zoo, Conservatory/Fern ery/Green house, Lath house.

24&25. Trees - Definition - Classification with suitable examples - Based on purpose: Specimen trees, Shady trees, ornamental trees, Flowering trees, Avenue or road side trees, Screening trees, windbreak trees, Fragrant flowering trees, Pollution controlling trees; classification based on - Climatic, Soil, availability and Cost factors - Planting Schemes for avenue planting: One kind of flower ing tree on both sides, two kinds of flowering trees blooming at one time on both sides of road, Two kinds of flowering trees blooming at different times on both sides of road and shady trees only on both sides of road - growing of trees: Propagation of trees, Methods of planting, Time of planting, Manuring and Care and Maintenance - canopy management.

26&27. Shrubs - Definition - Utility (aesthetic values) - Classification with suitable examples - based on beauty of plant parts: Flowering, Foliage, Flowering and foliage, Fragrant shrubs, for fruits; based on sunlight requirement: shrubs requiring full sunlight, semi shade, intermediate group (semi shade and sun); based on height: dwarf, medium and tall shrubs; based on purpose of growing: Specimen shrub, Standard and half standard shrub, rock gardens, edge, hedge, screen, ground cover, topiary, pot plant and Shrubbery (Arrange ment of shrubbery: According to height and colour) - Growing of shrubs: Soil and Preparation of site, Planting, Propagation: seeds, Cuttings, layering, Irrigation, weeding and pruning.

28. Herbaceous perennials - Definition - Introduction - Classification with suitable examples: Herbaceous perennials for plains and for hills - Growing of herbaceous perennials: Propagation, Planting and Manuring.

29&30. Climber and creepers: Utility (aesthetic values) - Classification with suitable examples - based on situation: Sunny situation, Partial shade, shade loving/ indoor climbers and screening walls; based on beauty of plant parts: Showy flowering climbers, Climbers with scented flowers, Climbers with attractive

foliage, based on rate of growth: Heavy climbers and Light climbers; based on nature of climber: Annual climbers and and perennial Climbers - growing of climbers and creepers: Soil, Digging of pits, Planting of climbers, After care, Manuring and Maintenance.

31&32. Annuals - definition - classification - based on season: summer annuals, winter annuals and rainy annuals; based on height: dwarf, medium and tall; based on flower colour; based on commercial value: cut and loose flowers; based on situation: carpet bed, for climbing, dry flower arrangement, edge, fragrance, hanging basket, ornamental foliage, pots, rockery, screening shade, indow sill - growing of annuals: soil, propagation: nursery management, manures and fertilizers - annual borders - herbaceous border: colour scheme, grouping - aftercare and maintenance.

33. Palms - Definition - Introduction - Utility (aesthetic values) - Classification with examples: Feather leaved Palm and Fan leaved Palm - growing of palms: Propagation, Pot culture: Potting, Re-potting and Potting media, Manuring and Aftercare.

34.&35. Ferns - Introduction - Utility (aesthetic values) - Propagation: Spore, Division of Clumps, Suckers and bulbils - growing of ferns: Site of growing, Soil media, Pot culture: repotting, Irrigation - Indoor culture - Important Examples. Selagi nellas - Introduction - Propagation - Cultural hints - Important Examples

36. Ornamental grasses: Bamboos and reeds - Introduction - growing of grasses: Propagation, Soil and climatic requirements, Site of growing, Planting - Import ant Examples.

37. Cacti - Introduction - Characteristics of Cactaceae - Site of growing – Natural habitat - Domestication (Housing of cacti) - growing of cacti: Propagation: Seeds, Offsets and Grafting, soil, Climate, Containers, Time and method of planting, Potting, Re-potting, Irrigation and Staking.

38. Succulents - Characteristics - Difference between cacti and succulents - Utility (aesthetic values) - growing of succulents: Climate, Soil, Housing, Propagation: Seeds and Cuttings, Watering, Re-potting and Summer protection.

39. Pot plants: introduction - pots - potting - potting - compost - repotting - arrangement - management.

40. Bio-aesthetic Planning: Definition - Aim and Concept - Need for Bio-aesthetic planning: Air pollution and Human welfare.

41&42. Landscaping of urban and rural areas, Peri-urban landscaping - Road side - Planting trees in colonies- Landscaping City parks: Large, medium, small parks and pleasure grounds - Examples of ornamental shade and flowering trees for town roads.

43&44. Landscaping of schools, public places like bus station, railway station, town ships, river banks, hospitals, play grounds, airports, industries, institutions: Impo rtance, Need and Planting materials for different areas of institutions

45&46. Bonsai: Definition - Criteria for selecting plants - Examples - Classification of Bonsai: Upright (formal and informal), Winding, Oblique, Gnarled, Semi-cas cade, cascade and Clasped to stone - growing of bonsai: Containers (pots) and Media, Potting and Re-potting, Training, Pruning and Pinching (Shoot, leaf and root), Watering, manuring, Defoliation - Mame Bonsai.

47&48. Computer Aided Designs (CAD) – Introduction - history - objectives -

component - Applications in landscaping

Parcticals

1. Identification of trees
2. Identification of shrubs
3. Identification of annuals
4. Identification of pot plants
5. Propagation of trees
6. Propagation of shrubs
7. Propagation of annuals
8. Identification of tools and implements used in landscape design
9. Training and pruning of plants for special effects
10. Lawn establishment and maintenance
11. Care and maintenance of plants, potting and repotting
12. Layout of formal gardens and informal gardens
13. Layout of special type of gardens (sunken garden, terrace garden, rock garden)
14. Designing of conservatory and lath house.
15. Use of computer software in landscaping
16. 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.

ELCT 482
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

Course outlines

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 equip-

ment identification and application, Micro propagation, Nursery- portrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/ nursery.

Lecture Outlines

Theory

1. Hi-tech horticulture - Introduction - Scope, importance and constraints - Perspectives of Hi-tech horticulture in India
2. Hi-tech nursery management - Quality standards of planting material- advantages of plant propagation under green houses
3. Micro propagation of horticultural crops - Procedure for tissue culture - Applications of micro propagation (Meristem culture, Anther culture, embryo culture, somatic hybridization and ovule culture)
4. Problems in micropropagation - Advantages and limitations - Micro-grafting
5. Modern field preparation methods - Raised bed preparation
6. Soil less culture - Hydroponics and Aeroponics
7. Mechanization - Importance of mechanisation in Hi-tech horticulture - Advantages and Disadvantages
8. Mechanisation of nursery, sowing and transplanting, plastic mulching, Irrigation, fertigation, pest and disease control, weed control, Harvesting etc.
9. Role of plastics in hi-tech horticulture
10. Plastic mulching - Types - Advantages and Disadvantages
11. Protected cultivation- advantages and disadvantages
12. Types of protected structures - glass house, poly house, rain shelters, poly tunnels, Hot beds and cold flames, shade nets etc.
13. Green houses - Definition - History - Greenhouse effect - Advantages of green houses
14. Types of greenhouses - types of greenhouses based on shape, utility, construction and cladding material
15. Greenhouse - controlled conditions - Light, Humidity, Temperature, CO2
16. Greenhouse - controlled conditions - Ventilation and cooling in a greenhouse - Naturally ventilated, Fan and Pad cooling, forced air cooling etc.
17. Greenhouse - controlled conditions - Relative humidity, carbon-di-oxide level
18. Greenhouses - Soil sterilization methods - Physical and chemical methods
19. Off-season production of flowers - vegetable forcing - techniques
20. Off-season production of vegetables - vegetable forcing - techniques
21. Insects of greenhouse crops - Springtails, beetles, sawflies, aphids, thrips, red spider mites, slugs and snails, symphilids, millipedes etc. and their management - Integrated Pest management in Greenhouse
22. Greenhouses - Nematodes and their management
23. Disease management in green houses - Bacterial blight, bacterial canker, bacterial leaf spots- viral diseases - Fungal Diseases - Downy Mildew, Powdery mildew, Sclerotinia rot, Damping off
24. Micro irrigation systems - Advantages and Disadvantages – methods and its components – Surface drip, sub-surface drip irrigation
25. Micro irrigation system - methods and its components - Bubblers, micro sprinkler Maintenance of micro irrigation systems
26. Fertigation - Advantages - Limitations - Method of fertilizer injection (Fertilizer

injection system, Pressure differential injection system, Venturi injection system)-
27. Fertigation - Selection of fertilizers - solid fertilizers & liquid fertilizers
28. Site specific nutrient management - advantages and disadvantages
29. Canopy management - Importance of canopy management- principles of canopy management
30. Canopy management - Tools of canopy management (Rootstocks, Plant density, Training and pruning, nutrient management, growth retardants etc.)
31. Canopy management in Mango and Guava
32. High Density orcharding - Concept – HDP systems
33. Components of HDP (use of genetically dwarf scion cultivars, dwarf rootstocks, pruning and training, use of growth retardants, induction of viral infection, use of incompatible rootstocks etc.)
34. Impact of HDP- Advantages- Constraints in HDP
35. Precision farming - Definition - Scope and status of precision farming in India
36. Perspectives and potentials of precision farming in India - components of precision farming.
37. Remote sensing - Role of Remote sensing in precision farming
38. Application of remote sensing in the field of horticulture
39. Geographical Information System (GIS) - Role of GIS in precision farming
40. Differential Global Positioning System (DGPS) – GPS introduction - Types of GPS
41. DGPS uses in Agriculture - Yield monitoring, field mapping, precision crop input application (fertilizers, pesticides, weedicides etc.)
42. Variable Rate applicator (VRA) - Introduction - Variable rate application methods - map based VRA and Sensor based VRA
43. VRA management zones - Seeding VRA, Weed control VRA, Lime VRA, Fertilizer VRA
44. Strategic approaches of precision technology for improvement of fruit production
45. Mechanized harvesting of produce - Advantages and disadvantages of mechanical harvesting
46. Mechanical harvesters developed for different horticultural crops – Robotics in harvesting
47. Green food production - Approaches - Biodynamic farming
48. Biodynamic preparations - Cosmic integration - Biodynamic calendar - Strategies for green food production

Practical

1. Types of polyhouses
2. Shade net houses
3. Identification and application of tools and equipment's
4. Intercultural operations for horticultural crops
5. Micro propagation
6. Nursery raising in protrays
7. Study of Micro-irrigation system and its components
8. Problems of micro irrigation systems
9. Study of mechanical harvesters
10. Study on bio dynamic preparations
11. Fertilizer scheduling
12. Canopy management in mango

13. Canopy management in Guava
14. Canopy management in Grapes
15. Visit to Hi-Tech orchard
16. Visit to Hi-Tech nursery

Suggested Readings

1. Durga Hemanth Kumar Ch., Ratna Kumari N., Naram Naidu L and Srilatha V., 2024. Glimpses of Hi Tech Horticulture. Bhavya Books, New Delhi..
2. Prasad, S. And Kumar, U. 2012. Greenhouse Management of Horticultural Crops. 2nd edition, Agribios publishers, New Delhi.
3. Singh, H.P., Singh, G., Samuel, J.C., and Pathak, R.K.. 2003. Precision Farming in Horticulture. NCPAH, MOA, PFDC, CISH, Lucknow
4. Sahu, K.C. 2008. Text Book of Remote Sensing and Geographical Information Systems. Atlantic publishers & Distributors
5. S. Prasad, Dharam Singh and R.L. Bharadwaj. Hi Tech Horticulture (Pb) by. Agrobios
6. Instant Horticulture by S.N. Gupta. Jain Brothers.
7. Hydroponics for Beginners and Advanced: The Ultimate Hydroponic and Aquaponic Gardening Guide by Tom Garden, Webb Eleanor.

ELCT 483
PROTECTED CULTIVATION
4 (3+1)

Objectives

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

Course Outlines:

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, Temperature control Automation. Soil preparation and management, Substrate management. Types of benches and containers, Irrigation and Fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops-rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants etc. Cultivation of economically important medicinal and aromatic plants. Off-season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, Use of protrays 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.

Lecture Outlines

Therory

1. Protected cultivation- Importance and scope - Status of protected cultivation in India.
2. World types of protected structure based on site and climate - Glass house, poly

house, rain shelters, poly tunnels, hotbeds and cold flames, shade nets.

3. Greenhouses - Definition- History - Greenhouse effect - Advantages of greenhouses.
4. Types of greenhouses - Types of greenhouses based on shape, utility, construction and cladding material.
5. Greenhouse design - Locating a greenhouse, greenhouse orientation - Layout of greenhouse - Material requirement - Erection.
6. Cladding materials for greenhouse/ poly house - Glass, Flexible plastic films, poly ethylene, Ethylene Venyl acetate, Poly venyl fluoride, poly venyl chloride,
7. Cladding materials - Acrylic, Tefzel T2film, Reinforced plastic, Rigid plastic sheet, Saran plastic mesh.
8. Environment control - Light - Supplemental lighting - Incandescent lamp, fluorescent lamp, high intensity discharge lamps.
9. Temperature control - Ventilation and cooling in a greenhouse - Naturally ventilated, Fan and Pad cooling, forced air cooling etc
10. Relative humidity control - Carbon di-oxide fertilization - CO2 levels
11. Soil preparation and management - Soil sterilization methods – Physical & Chemicals
12. Soil and soilless media (coco peat, vermicompost, perlite, vermiculite, charcoal, pumice, rock wool etc.,) - Substrate management.
13. Types of benches and containers - No bench, raised benches, ground benches - Arrangement of benches - Longitudinal, cross-benching, peninsula arrangement
14. Movable benches, pyramid benches - Containers - Types of containers.
15. Irrigation management - Water application methods - Hand watering and automatic watering systems- Tube watering, capillary mat, overhead sprinklers, perimeter watering, drip system, misting
16. Fertigation - Dry and liquid fertilizers - Methods of application of liquid fertilizers (constant feed and intermittent feed).
17. Automation - Parameters to be controlled - Types of greenhouse control - Step control, integrated control, feedback, proportional, integral, derivative, feed forward, energy balance, sensors (Temperature, Light, CO2 , Humidity, Irrigation etc.).
18. Propagation and production of quality planting material of horticultural crops - Asexual and sexual methods of propagation.
19. Greenhouse cultivation of important horticultural crops - Rose - Introduction - varieties suitable for greenhouse cultivation - Climatic requirements - Planting - Spacing, planting density.
20. Fertilizer requirement - Fertigation - Training and pruning - Special intercultural operations (Defoliation, De-shooting, Bending, Disbudding etc.) - Use of growth regulators - Physiological disorders - Harvesting - Grading & packing - Yield.
21. Carnation - Introduction - Varieties suitable for greenhouse cultivation - Climatic requirements - Planting - Spacing, planting density - Fertilizer requirement - fertigation
22. Training, pruning - Special intercultural operations (Netting, Pinching) - Use of growth regulators - Harvesting - Grading & packing - yield.
23. Chrysanthemum - Introduction - Varieties suitable for greenhouse cultivation - Climatic requirements - Planting - Spacing, planting density
24. Chrysanthemum - Fertilizer requirement - Fertigation - Training, pruning - Special intercultural operations (pinching, disbudding, staking, de-suckering) - Use

of growth regulators - Harvesting - Grading & packing - yield.

25. Gerbera - Introduction - Varieties suitable for green house cultivation - Climatic requirements - Planting - Spacing, planting density - Fertilizer requirement - Fertigation
26. Special intercultural operations (Defoliation, soil loosening, shading) - Use of growth regulators - Harvesting - Grading & packing - Yield.
27. Orchids - Varieties for green houses production - Climatic and substrate requirement - Propagation
28. Planting - Fertilizer requirement- Use of growth regulators - Physiological disorders - Harvesting - Grading and packing - Yield.
29. Anthurium - Varieties suitable for green house cultivation - Climatic requirements - Growing media - Planting - Spacing, planting density - Fertilizer requirement - Fertigation
30. Special intercultural operations (Defoliation, de-suckering) - Use of growth regulators - Physiological disorders- Harvesting - Grading & packing - Yield.
31. Lilium - Varieties suitable for green house cultivation - Climatic requirements - Growing media - Planting - Spacing, planting density - Fertilizer requirement -
32. Special intercultural operations (Defoliation, de-suckering) - Use of growth regulators - Physiological disorders- Harvesting - Grading & packing – Yield.
33. Tulip - Varieties suitable for green house cultivation - Climatic requirements - Growing media - Planting - Spacing, planting density - Fertilizer requirement
34. Special intercultural operations (Defoliation, de-suckering) - Use of growth regulators - Physiological disorders - Harvesting - Grading & packing - Yield.
35. Tomato - Varieties suitable for green house cultivation - Climatic requirements - Soil preparation - Planting - Spacing, planting density
36. Training and pruning methods - Fertilizer requirement - Intercultural operations - Harvesting - Yield.
37. Bell pepper - Varieties suitable for green house cultivation - Climatic requirements - Soil preparation - Planting - Spacing, planting density.
38. Training and pruning - Fertilizer requirement - Intercultural operations - Harvesting - Yield
39. Cucumber - Varieties suitable for green house cultivation - Climatic requirements - Soil preparation - Planting - Spacing, planting density.
40. 40 Training and pruning - Fertilizer requirement - Intercultural operations - Harvesting - Yield.
41. Strawberry - Varieties suitable for green house cultivation - Climatic requirements - Soil preparation - Planting - Spacing, planting density.
42. Training and pruning - Fertilizer requirement - Intercultural operations - Harvesting - Yield.
43. Pot plants - Selection of plants - Climatic requirement - Potting and Repotting - Management of pot plants.
44. Cultivation of economically important medicinal - Stevia, Ginseng and aromatic plants.
45. Off-season production of flowers and vegetables - Flower forcing - Techniques - Vegetable forcing - Techniques.
46. Insects of greenhouse crops - Springtails, beetles, sawflies, aphids, thrips, red spider mites, slugs and snails, symphilids, millipedes etc. and their management - In-

tegrated Pest management in Green house.
47. Disease management in green houses - Bacterial blight, bacterial canker, bacterial leaf spots - Viral diseases - Tomato spotted wilt virus - Fungal Diseases - Downy Mildew, Powdery mildew, Sclerotinia rot, Damping off
48. Nematodes and their management in greenhouses

Practicals

1. Study of different types of greenhouses based on shape.
2. Study of different types of greenhouses based on construction.
3. Study of different types of greenhouses based on cladding material.
4. Study of materials for construction of greenhouses.
5. Study of construction of pipe framed greenhouse.
6. Field visit to green house.
7. Raising of seedlings and saplings under protected conditions.
8. Use of protrays in quality planting material production.
9. Bed preparation and planting of crop for production.
10. Intercultural operations in greenhouse crops
11. Regulation of irrigation in green houses
12. Fertilizers application through drip, fogging ad misting.
13. Soil EC and pH measurement.
14. Measurement of environmental parameters inside greenhouse.
15. Calculation of ventilation rates in active summer cooling system.
16. Calculation of rate of air exchange in active winter cooling system

Suggested Readings

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

ELCT 484
POST-HARVEST TECHNOLOGY AND VALUE ADDITION
4 (3+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

Course outlines

Theory

Importance of Post-harvest Processing of fruits and vegetables, extent and possible causes of post harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting

respiration rate; Role of ethylene; Post harvest disease and disorders; Heat, chilling and freezing injury; 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 packaging containers for shelf life extension, Effect of temperature on shelf life and quality of produce, Demonstration of chilling and freezing injury in vegetables and fruits, Extraction and preservation of pulps and juices, Preparation of jam, Preparation of Jelly, Preparation of RTS, Preparation of Nectar, Preparation of Squash, Osmotically dried products, Fruit bar and Candy and Tomato products, Canned products, Quality evaluation of products - Visit to processing unit/ industry

Lecture Outlines

Theory

1. Scope and Importance of postharvest technology of fruits and vegetables- extent and possible causes of postharvest losses- Causes of postharvest losses
2&3. Pre-harvest factors affecting postharvest quality, maturity, ripening and shelf life of fruits and vegetables - Environmental factors (Temperature, Light, Rain fall, Wind, Relative humidity)
4. Pre-harvest factors - Cultural factors - Rootstock, Variety, Mineral nutrients, growth regulators, Irrigation, pruning, thinning, girdling
5. Methods for determination of maturity indices
6. Maturity indices of Fruits and Vegetables
7. Harvesting and field handling - Methods of harvesting
8. Postharvest handling - Different pre-cooling methods
9. Cleaning of Fruits & Vegetables - Soaking - Rinsing - Cleaning & Washing - by agitator - by spraying water - Wet and dry brushing
10. Postharvest treatments - Waxing, Wrapping, de-greening, ripening, Chemical washing and Disinfestation
11. Storage - Methods of storage - Traditional storages (In-situ, Pit storage, high altitude, clamp storage, wind breaks, cellars, barns, Night ventilation)- Evapo rative cool storage ZECC principle - Cold storage
12. Improved storage methods -Refrigerated storage, modified Atmospheric stor age, Controlled Atmospheric Storage, Hypobaric storage
13&14 Changes occurring during ripening - Ripening definition - Climacteric and non-climacteric fruits - Metabolic changes - maturation of seeds - colour - tex ture - changes in carbohydrates
15 Changes occurring during ripening - changes in aromatic volatiles - changes in organic acids - fruit abscission - changes in respiration rate - development of surface waxes - changes in tissue permeability
16. Causes for deterioration of harvested fruits and Vegetables -Respiration and factors affecting respiration rate - Transpiration and factors affecting transpi ration
17. Role and importance of ethylene during ripening of fruits
18. Postharvest diseases and disorders in fruits and vegetables

19. Heat, chilling and freezing injury in fruits and vegetables
20. Value addition - Concept - Scope and importance of fruit preservation in India - status of fruit preservation in India
21. Principles and methods of preservation - principles of preservation - preserva tion methods - Asepsis, High temperature, low temperature
22. Methods of preservation - Preservation by drying, filtration, chemical preser vation, fermentation, carbonation, salt, sugar, irradiation
23. Drying/Dehydration of fruits and vegetables - Factors affecting the drying - Advantages of drying/ dehydration over sun drying
24. Dryers for fruits and vegetables - tray dryers, tunnel dryers, conveyor dryers or belt dryers - foam mat drying - fluidized bed dryers
25. Dryers for fruits and vegetables - Roller or drum dryers, Spray dryers, pneu matic dryers, microwave drying, vacuum drying
26. Rotary dryers, freeze dryers, Osmotic drying – Principle - Advantages and disadvantages
27. Freezing - Slow and fast freezing - Advantages and disadvantages
28. Freezing methods - Direct immersion - Indirect contact with refrigerant, Air blast freezing, Cryogenic freezing, De-hydro freezing - Freeze-drying (Flow - chart)
29. Intermediate moisture foods - Jam - Problems in Jam making
30. Intermediate moisture foods - Jelly - Problems in in Jelly making
31. Intermediate moisture foods - Marmalade - Problems in Marmalade making
32. Pickle making-Problems in pickle making-Spoilage of pickles
33. Pickles preparation in Fruit and Vegetables
34. Preserve, candy - Concepts and Standards - Flow chart for manufacturing of preserve and candy - problems in preservation of preserve and candied fruits
35. Glazed fruits/vegetables - Flow chart for manufacturing of glazed fruits/vege tables - preservation

36&37. Fruit beverages - Unfermented - Juices, Ready to serve, Nectar, cordial, Squash -Preparation and preservation of unfermented fruit beverages -Unfermented beverages - Crush, Syrup, Fruit Juice concentrate, Fruit Juice Powder, Carbonat ed beverages - Preparation and preservation of unfermented fruit beverages

38. Fruit beverages - Fermented beverages - Wine, Champaign, Port, Sherry, Tokay - Preparation and preservation of fermented fruit beverages - Fermented bev erages - Muscat, Perry, Nira, Feni, Cider - Preparation and preservation of fer mented fruit beverages
39. Tomato processing - Concepts and Standards - Tomato juice - Tomato puree and paste - Tomato sauce/ketchup-
40. Tomato processing -Tomato chutney/pickle - Tomato cocktail - Tomato soup - Canned tomatoes
41. Value added products of Banana and papaya
42. Value added products of Mango and Coconut
43. Canning of fruits and vegetables - Principle and process of canning - Causes of spoilage of canned foods
44. Canning - Testing for defects - Containers for packing of canned products - Tin containers, Glass containers
45. Packaging of products - Definition - properties of good packaging material -

Different types of packaging materials commonly used for raw and processed fruits and vegetables products – wooden containers, metal, glass containers

46. Plastics in packaging - Cello pave, Poly vinyl chloride, Polyethylene, Polyeth ylene, Ethyl v inyl alcohol
47. Food colours - Importance - Natural (Carotenoids, Anthocyanins, betalains, curcumin etc.) and Artificial - FSSA permitted food colours
48. Food safety standards-Rules and Regulations-Food Safety Standards Authority of India (FSSAI)-Fruit Product Order (FPO)- Hazard Analysis and Critical Con trol Point (HACCP)

Practicals

1. Types of packaging materials
2. Cushioning materials for packing and transport of horticultural produce
3. Practicing drying techniques
4. Effects of low and high temperatures (Chilling & freezing injury and heat injury in and Fruits and Vegetables
5. Extraction and preservation of pulps.
6. Preparation of jam
7. Preparation of jelly
8. Preparation of RTS
9. Preparation of nectar
10. Preparation of squash
11. Preparation of osmotically dried products
12. Preparation of fruit bar and candy
13. Preparation of tomato sauce
14. Preparation of tomato ketchup
15. Shrink Wrapping in fruits and vegetables.
16. Visit to processing unit/ industry.

Suggested Readings

1. Giridharilal, G.S., Siddappa and Tondon, G.L. 2007. Preservation of Fruits and Vegetables.ICAR, New Delhi.
2. Mitra, S.K. 2005. Post-Harvest Physiology and Storage of Tropical and Subtropical Fruits. CABI Publishers, Kolkatta.
3. Rathore, N.S., Mathur, G.K., Chasta, S.S. 2012. Post-harvest Management and Processing of Fruits and Vegetables. ICAR, New Delhi.
4. Srivastava, R.P. and Sanjeev Kumar. 2002. Fruit and Vegetable Preservation: Principlesand Practices.
5. International Book Distribution Company, Lucknow.

ELCT 485
ORNAMENTAL CROPS, MAPS & LANDSCAPING
4 (3+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

Course Outlines

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 lilium; 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.

Lecture Outlines

Theory

1. Importance and scope of ornamental crops and landscaping
2. Landscape uses of trees, shrubs and climbers
3. Principles of landscaping - Initial approach - Axis - Focal Point - Mass effect - Unity - Space - Divisional Lines - Proportion and Scale - Texture - Time and Light - Tone and Colour - Mobility - Rhythm - Balance - Contract - Harmo- Vista - Style.

4&5. Production technology of cut flowers under protected conditions; Rose - Intro duction- origin and distribution- classification- species and varieties- climate and soil requirements- propagation - Rootstocks- Stock scion compatibility - land preparation- planting- Manures and fertilizers- cultural operations (pruning- pinching and mulching) harvesting- post harvest managment - yield

and rose bi-products.

6&7. Gerbera - Introduction- origin and distribution- classification- species and varieties- climate and soil requirements- propagation- land preparation - planting- Manures and fertilizers- cultural operations- soil loosening - Shading - use of growth regulators- physiological disorders- harvesting - post harvest management and yield.

8&9. Chrysanthemum - Introduction - origin and distribution- classification- species and varieties - climate and soil requirements- propagation- land preparation- planting - Manures and fertilizers- cultural operations- (pinching and disbudding) - use of growth regulators - harvesting- post harvest management and yield

10&11. Carnation - Introduction- origin and distribution- classification- species and varieties- climate and soil requirements- propagation- land preparation- plant ing- Manures and fertilizers- cultural operations- (pinching and disbudding) - use of growth regulators- physiological disorders- harvesting- post harvest management and yield.

12&13. Orchids - Introduction- origin and distribution - classification- species and va rieties- climate and soil requirements - propagation- land preparation - plant ing- Manures and fertilizers- cultural operations- use of growth regulators- physiological disorders- harvesting- post harvest management and yield.

14&15. Lilium - Introduction- origin and distribution- classification- species and vari eties- climate and soil requirements- propagation- land preparation- planting- Manures and fertilizers- cultural operations- use of growth regulators- physio logical disorders- harvesting- post harvest management and yield.

16&17. Anthurium - Introduction, origin and distribution, classification, species and varieties, climate and soil requirements, growing media, propagation, systems of growing, planting- Fertigation - cultural operations, de-suckering - defolia tion - use of growth regulators, physiological disorders – harvesting - post har vest management and yield.

18&19. Production technology of cut flowers under open conditions; Gladiolus - Introduction- origin and distribution- classification of varieties- species and varieties- climate and soil requirements- propagation- land preparation- plant ing- Manures and fertilizers- cultural operations- use of growth regulators- physiological disorders- harvesting- post harvest management and yield.

20&21. Tuberose- Introduction- origin and distribution- classification of varieties- spe cies and varieties- climate and soil requirements- propagation- land prepara tion- planting- Manures and fertilizers- cultural operations- use of growth reg ulators- physiological disorders- harvesting- post harvest management and yield.

22&23. Loose flowers - Marigold - Introduction- origin and distribution- species and varieties- F1 Hybrids- climate and soil requirements- propagation- land prepa ration- planting- Manures and fertilizers- cultural operations- (pinching and disbudding) use of growth regulators- harvesting- post harvest management and yield.

24&25. Jasmine - Introduction- origin and distribution- species and varieties- F1 Hy brids- climate and soil requirements- propagation- land preparation- planting – Manures and fertilizers- cultural operations- use of growth regulators- har

vesting- post harvest management and yield.

26&27. Crossandra - Introduction- origin and distribution- species and varieties- F1 Hybrids- climate and soil requirements- propagation- land preparation- plant ing – Manures and fertilizers - cultural operations- (pinching and disbudding) use of growth regulators- harvesting- post harvest management and yield.

28. Post-harvest handling of cut flowers

29. Medicinal plants - Scope and Importance - Production technology of Ashwa gandha - Botanical name - Family - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Inter cultural operations - Harvesting - Yield.

30. Aloe, Costus - Botanical name - Family - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - In tercultural operations - Harvesting - Yield

31. Periwinkle, Isabgol -Botanical name - Family - Origin - Economic part - Intro duction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irriga tion - Intercultural operations - Harvesting - Yield

32. Coleus, Glory lily -Botanical name - Family - Origin - Economic part - Introduc tion - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield

33. Belladonna - Botanical name - Family - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Inter cultural operations - Harvesting - Yield

34. Dioscorea -Botanical name - Family - Origin - Economic part - Introduction - Climate – Soil - Varieties - Propagation - Planting - Manuring - Irriga tion - Intercultural operations - Harvesting - Yield

35. Rauvolfia -Botanical name - Family - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Inter cultural operations - Harvesting - Yield

36. Aromatic plants - Importance - Essential oil industry in India - Properties of essential oils – Production technology of Lemon grass - Botanical name - Fami ly - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propaga tion - Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield

37. Citronella, Palmarosa - Botanical name - Family - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield

38. Mint & Ocimum - Botanical name - Family - Origin - Economic part - Introduc tion - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield

39. Geranium & Davanam - Botanical name - Family - Origin - Economic part - Introduction - Climate - Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield

40. Vetiver - Botanical name - Family - Origin - Economic part - Introduction - Climate – Soil - Varieties - Propagation - Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield

41. Brief concept of Home landscaping, Carpet bedding and Topiary

42. Bonsai - Styles, plants and containers - Cultural Practices, Special Practices,

Care and Maintenance

43. Lawn - Grasses- Establishment and maintenance
44. Flower arrangement - Principles - Styles - Japanese style - Ikebana
45. Herbaceous Border - Hedges and Edges - Plants used - Growing and mainte nance
46. Dehydration technique for drying of flowers - Importance - Pot - pourri - Dehy dration methods - Air drying - Embedding and drying - viz., room drying – Sun drying - hot air oven - vacuum drying - microwave drying - Press drying
47. Extraction methods of essential oils- distillation methodology, advantages and disadvantages of water distillation, water and steam distillation, steam distilla tion.
48. Extraction methods of essential oils – cold fat extraction, hot fat extraction, solvent extraction, expression, Super critical fluid extraction, storage of essential oils.

Practicals

1. Identification of ornamental plants
2. Identification of Medicinal and Aromatic Plants
3. Nursery bed preparation and sowing of seasonal flower seeds
4. Propagation of Medicinal and Aromatic Plants.
5. Bed preparation and planting of Medicinal and Aromatic Plants
6. Propagation of ornamental plantsby terminal/herbaceous cuttings.
7. Propagation of Anthurium and orchids
8. Propagation of bougainvillea
9. Planting of gerbera suckers and gladiolus corms
10. Establishment and maintenance of lawn
11. Preparation of flower preservatives and their use in extending the vase life of cut flowers
12. Training and pruning of ornamental plants and raising of hedge and edge
13. Planning and layout of garden
14. Drying / dehydration techniques for flower drying
15. Extraction of essential oils
16. Visit to commercial flower unit/MAP unit

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,
3. P. Rangaswamy, I. Irulappam
4. Textbook of floriculture and landscaping by Anil K. Singh and Anjana Sisodia
5. Commercial flowers (Vol 1 and 2) by T.K. Bose.

EXTENSION EDUCATION

AEC 191
COMMUNICATION SKILLS
2 (1+1)

Objective

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

Course Outlines

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. Precise writing/abstracting/summarizing. Style of technical communication. Curriculum vitae/ resume writing. Innovative methods to enhance vocabulary, analogy questions.

Structural and functional grammar: Sentence structure, modifiers, connecting words and verbals. Phrases and clauses. Case: subjective case, possessive case, objective case. Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles. Agreement of verb with the subject: tense, mood, voice. Writing effective sentences. Basic sentence faults.

Practical

Listening and note taking. Writing skills; precise 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.

Lecture Outlines

Theory

1. Communication: Definition, Meaning, Concept, Nature, Significance / Functions of Communication and Magic of effective Communication Process.
2. Self Esteem: Building Self-Esteem and Overcoming Fears.
3. Communication Process: Elements, Characteristics, Models.
4. Types of Communication:Verbal and Non Verbal Communication: Definition, Meaning, Types, Characteristics, Advantages and Disadvantages.
5. Communication Barriers: Linguistic and Non-Linguistic Barriers to Communication and Reasons behind Communication Gap / Miscommunication.
6. Listening Skills: Definition, Meaning, Types, Stages in the Process and Techniques of increasing Listening Efficiency and Speaking Skills: Definition, Meaning, Types and Steps in the Preparation of Speech
7. Reading Skills: Definition, Meaning, Typesand Writing Skills: Definition, Meaning, Characteristics, Principles, Process, Types of Writing Styles, Forms of Written Communication, Pointers and Tips for effective Written Communication, Advantages and Disadvantages.

8. Precise Writing: Definition, Meaning, Characteristic Features of Good Précis, Do's and Don'ts of Précis Writing / Abstracting / Summarizing. Technical / Professional Communication: Importance, Choice of Words and Phrases, Clichés, Jargons, Foreign words and Phrases and Style of Technical / Professional Communication.
9. Curriculum Vitae / Resume Writing: Personal, Social, Educational, Professional, Training, Achievements, Hobbies and Reference Profile Making
10. Vocabulary and Analogy: Innovative Methods to enhance Vocabulary: Words often Confused, Correct and Incorrect Words and Homophones and Analogy Questions.
11. Structural Grammar: Sentence Structure and Modifiers, Connecting Words and Verbal's.
12. Structural Grammar: Phrases and Clauses
13. Structural Grammar: Case - Subjective Case, Possessive Case: Objective Case.
14. Structural Grammar: Correct usage of Nouns, Pronouns and Antecedents, Adjectives, Adverbs and Articles.
15. Functional Grammar: Agreement of Verb with the Subject: Tense, Mood, Voice.
16. Functional Grammar: Writing effective Sentences; Basic Sentence Faults.

Practicals

1. Listening Skill
    - Lecture cum Discussion on Types and Stages in the Listening Process
    - Simulated Exercise on Listening Skill:
        - » Viewing 10 - 20 Minutes Video on Agricultural Production Technology
        - » Answering to 5 Minutes Quiz.
2. Note Taking
    - Recapitulation on Techniques of Note Taking, Suggestions for Note Taking and Uses
    - Reading Chapter on "Audio - Visual Aids and Information Communication Technology (ICT)" in Book on 'Fundamentals of Agricultural Extension Education' authored by SAGAR MANDAL
    - Assignment for depicting Topic through different Methods of Note Taking
3. Writing Skills:
    - Recapitulation on Definition, Meaning, Characteristics, Principles, Process, Forms of Written Communication, Pointers and Tips for effective Written Communication, Things to keep in mind while Writing, Advantages and Disadvantages and Type of Writing Styles.
    - Simulative Exercise on Writing Styles and Writing 20 Sentences on any Topic.
    - Finding out the Defects in Sentence Construction by Students
4. Precis Writing, Summarizing and Abstracting:
    - Recapitulation on Definition, Meaning, Characteristic Features of Good Precis, Do's and Don'ts of Precis Writing / Abstracting / Summarizing.
    - Allocation of any one Topic and finding out the Precis Writing / Abstracting /Summarizing Skills of Students
5. Reading and Comprehension (Written and Oral) of General Articles.
    - Exercise to make Personal Observations on Writing Styles followed in the Informal Journals / Magazines: Intensive Agriculture; Indian Farming, Indian Horticulture, Yojana and Kurukshetra,

6. Reading and Comprehension (Written and Oral) of Technical Articles:
    - Exercise to make Personal Observations on Technical Writing Styles followed in the Formal Journals Journal of Research, ANGRAU: Andhra Agricultural Journal; Andhra Pradesh Journal of Agricultural Sciences, Research Journal of Agriculture; Indian Journal of Agricultural Sciences, Indian Journal of Extension;
7. Micro - Presentations:
    - Lecture cum Discussion on Definition, Meaning, Structure, Types, Tips, Guidelines (Do's and Don'ts) and Purpose
    - Five Minutes Extempore Presentation by students on any Topic instantaneously given
8. Impromptu Presentations:
    - Lecture cum Discussion on Definition, Meaning, Types, Formats, Structure, Techniques, Tips and Benefits
    - Assigning Group Exercise to students on different Formats of Impromptu Presentations
9. Feedback on Presentations:
    - Lecture cum Discussion on Definition, Meaning, Functions, Types, Evaluation Criteria for Feedback, Importance, Tips for effective Feed back
    - Assigning Group Exercise to derive Feedback on any Modern Agricultural Technology.
10. Stage Manners: Grooming and Body language:
    - Lecture cum Discussion on Definition, Meaning, Basics, Attributes and Factors of Good Grooming, Body Language: Meaning, Definition, Elements, Tips and 5Cs of Body Language, Role and Importance in Communication
    - Assigning Topics on any Modern Agricultural Technology to derive Feedback after PPT Presentation.
11. Stage Manners: Voice Modulation and Speed:
    - Voice Modulation: Definition, Meaning, Elements / Components and Importance and Speed of Delivery for different occasion
    - Assigning Topics on Agriculture to derive Feedback after PPT Presentation
12. Group Discussions:
    - Lecture cum Discussion on Small Group Discussion Methods, Objectives, Purposes, Procedure, Roles of Chairman and Members, Evaluation Criteria and Merits and Demerits
    - Simulated Exercise on group Discussion to find out the General Problem in Village and Specific Problems in any Crop Production Technology
13. Public Speaking:
    - Lecture cum Discussion on Definition, Meaning, Benefits, Elements, Steps of Preparation for Public Speaking.
    - Assigning Topics for Presentation on Types of Public Speaking
14. Vocabulary Building Exercise:
    - Definition, Meaning of Meaning of Antonyms, Synonyms, Homonyms, Homophones, Words often Confused, Correct and Incorrect Words, Words connected with Parts of Speech, Idioms and Phrases; Usages, Sayings and Abbreviations; Anglicized Words

- Assigning Topics to find out the Words often Confused, Correct and Incorrect Words

15. Interview Techniques:
    - Lecture cum Discussion on Definition, Meaning, Types, Techniques, Purpose, Body Language, Types of Questions to be asked in Interview and Strategies of Effective Interview
    - Group Exercise on Types of Interviews
16. Organization of Events:
    - Lecture cum Discussion on Definition, Meaning, Purpose, Steps and Tips in Organisation and Evaluation of Event
    - Group Exercise on Organisation and Evaluation of Event

Suggested Readings

1. Allport, G. W. 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter, S. J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar, S. and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James, W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman, M. and Singh, P. 2000. Business Communication. Oxford University Press.
9. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford University

AEXT 192
RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY
2 (2+0)

Objectives

After completion of this course, the students will be able to have:

1. Thorough understanding of the Extension Education, Agricultural extension and rural society
2. They will learn about the psychological aspects of rural people and management of their behaviour.
3. Knowledge of Identification of leaders, teaching and training methods

Course Outlines

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, andInterrelationship between Rural Sociology & Agricultural Extension. Indian Rural Society, Important characteristics, Differences and Relationship between Rural and Urban societies. Social Groups- Mean-

ing, 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 & Caste System. Cultural concepts- Culture, Customs, Folkways, Mores, Taboos, Rituals and 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 learningand their implication of teaching.

Lecture Outlines

Theory

1. Extension Education and Agricultural Extension: Meaning, definition, scope, Emerging Trends in Agricultural Extension
2. Importance Sociology and importance of rural sociology in India
3. Meaning, definition, scope, Modernization of rural societies, importance of rural sociology in Agricultural Extension
4. Interrelationship between rural and urban societies, Changing trends in Rural Livelihoods and their role in Agricultural Extension
5. Indian Rural Society: important characteristics
6. Differences and relationship between rural and urban societies. Effects of urbanization on rural societies
7. Social Groups: Meaning, definition, factors considered in formation, organization of groups, motivation in group formation
8. Characteristics of groups, groups vs society, groups vs community, functions of groups, role of social groups in Agricultural Extension
9. Social Stratification: Meaning, definition, functions, basis for stratification
10. Forms of social stratification- Characteristics, Social Mobility, Gender based Social Stratification in Rural Communities and differences between class and caste system
11. Cultural concepts. Culture, customs, folkways, mores, taboos, rituals. Traditions: Meaning, definition and their role in Agricultural Extension.
12. Importance of culture, structure of culture, socialization and elements of culture
13. Social Values and Attitudes: Meaning, definition, types and role of social values and attitudes in agricultural Extension

14. Social Institutions: Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension
15. Social Organizations: Meaning, definition, types and elements of organizations and role of social organizations in agricultural Extension
16. Social control: Meaning, definition, need of social control and means of social control. Traditional vs. Modern Mechanisms of Social Control in Rural Societies
17. Social change Meaning, definition, nature of social change, dimensions of social change and factors of social change.
18. Leadership: Meaning, definition, classification, roles of leader
19. Different methods of selection of professional and lay leaders
20. Training of leaders: Meaning, definition, methods of training
21. Advantages and limitations in ue of local leaders in Agricultural Extension
22. Psychology and educational psychology: Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. Behavioral Psychology in Adoption of Agricultural Innovations
23. Domains of learners Behaviour and Levels of Learners behaviour
24. Emotions, Meaning Typers and effect of Emotion Human beviour on techniques improve positive emotions
25. Frustration, meaning Definition types, Factors for frustration importance of Frustration in Agricultural extension
26. Intelligence Meaning definition, types, factors affecting intelligence and importance of intelligence in Agricultural Extension. Artificial Intelligence in Supporting Extension Services
27. Theories of intelligence, measurement and factors affecting intelligence and importance of intelligence in Agricultural Extension
28. Personality: Meaning, definition, types, factors influencing the personality and role of personality in agricultural extension
29. Teaching: Learning process: Meaning and definition of teaching, learning, learning experience and learning situation. E-learning Tools
30. Elements of learning situation and its characteristics. Blended Learning Approaches in Agricultural Education.
31. Steps in Extension teaching, teaching methods
32. Principles of learning and their implication of teaching. Gamification in Learning for Agricultural Extension

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. 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

AEC 193
PERSONALITY DEVELOPMENT
2 (1+1)

Objective

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

Course Outlines

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 Aand 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.

After completion of this course, the students will be able to:

- Realize their potential strengths
- Cultivate their inter-personal skills
- Improve employability.

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.

After completion of this course, the students will be able to:

- Enhance their skills in understanding their own as well as others personality
- Upgrade their skills in group performance

Lecture Outlines

Theory

1. Personality - Definition, Nature of personality, Theories of personality and its types
2. The humanistic approach - Meaning, Maslow's self-actualization theory, shaping of personality, determinants of personality.
3. Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.
4. Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour.
5. Perception - Meaning, types, factors and importance in Agricultural Extension and attributes and factors affecting perception.
6. Attribution theory – meaning of attribution, types of attributions, Weiner model of

attribution and case studies on Perception and Attribution.

7. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behaviour, difference between learning and training, learning feedback.
8. Attitude – concept, significance, factors affecting attitude, positive and negative attitude, ways to develop positive attitude
9. Values - definition, importance of values in organization, characteristics and types of values
10. Intelligence - meaning, types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence
11. Organizational behaviour - meaning, definition, scope and importance of organizational behaviour, models of organizational behaviour
12. Emotional Intelligence - meaning, components and dimensions of emotional intelligence
13. Emotional Intelligence - state and trait, characteristics of persons with emotional intelligence and low emotional intelligence
14. Motivation - Meaning, types of motives, theories and principles of motivation and importance of motivation in Agricultural Extension
15. Teamwork - Team work - Meaning, concept, characteristic features of effective teams, types of teams, factors affecting and role of team work.
16. Group dynamics - Nature of groups, dynamics of group formation, types of groups, dynamics of formal & informal groups.

Practicals

1. Assessing personality through MBTI personality analysis
2. Practicing Learning Styles and Strategies
3. Assessing Motivational needs
4. Administering psychological tests to assess personality types of human beings. Experiment: 1. Firo-B
5. Administering psychological tests to assess personality types of human beings. Experiment: 2. Eysenk personality inventory
6. Administering psychological tests to assess personality types of human beings. Experiment: 3. Edward's personality inventory
7. Practicing Interpersonal Communication
8. Practical exercise on Teamwork and team building
9. Practical exercise on Group Dynamics
10. Practical exercise on Win-win game
11. Measurement of Emotional Intelligence
12. Practical exercise on Leadership styles
13. Case studies on Personality and organizational behaviour
14. Practical exercise on Negotiation skills and Stress management
15. Practical exercise on Time management
16. Practical exercise on Conflict management

Suggested Readings

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: Wadswor.
9. Fred, Luthans. Organizational Behavior- Seventh Edition (International Edition), McGraw-Hill.

MDC 291
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

Course Outlines

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.

Lecture Outlines

Theory

1. AEXT - Concept of Entrepreneur, Entrepreneurship, need for and importance of entrepreneurial development
2. AEXT - Development of entrepreneurship, motivational factors, social factors, environmental factors.
3. AEXT - Characteristics of entrepreneurs, entrepreneurial attributes /competencies:
4. AEXT - Evolution of entrepreneurship: Approaches of entrepreneurship and theories of entrepreneurship
5. AEXT - Types of entrepreneurs, functions of entrepreneurs and importance of entrepreneurial development and process of entrepreneurship development
6. AEXT - Agri-entrepreneurship - Concept, need and scope. Characteristics of entrepreneurship useful for agripreneurship.
7. AEXT - Idea generation- Environment scanning and opportunity identification need for scanning
8. AEXT - Spotting of opportunity, scanning of environment identification of product/ service and preliminary screening of ideas
9. AEXT - Incubation and commercialization of business ideas- Researching/ managing competition
10. AEXT - Starting a project: Identification of sound enterprise, steps to be considered in setting up enterprise, factors influencing sensing the opportunities.
11. AEXT - SWOT Analysis- Concept, meaning and advantages
12. AEXT - Infrastructure and support schemes for entrepreneurship development
13. AEXT - Export and import policies relevant to Indian agriculture sector
14. AEXT - Role of financial institutions and other agencies in entrepreneurship development
15. AEXT - Venture Capital (VC), Contract Farming(CF), Joint Venture, Public Private Partnership (PPP)
16. AEXT - Steps involved in functioning of an enterprise
17. AEXT - Selection of the product/services, selection of form of ownership
18. AEXT - Registration, selection of site, capital sources, acquisition of, manufacturing know-how, packaging and distribution.
19. AECO - Planning of an enterprise, project identification, selection and formulation of project
20. AECO - Project report preparation, Enterprise management
21. AECO - Production management: Product, levels of products, product mix and quality control
22. AECO - Cost of production, production controls, material management, raw material costing and inventory control
23. AECO - Personal management: Man power planning, labour turn over, wages/salaries
24. AECO - Financial management/accounting: Funds, fixed capital and working capital
25. AECO - Costing and pricing, long term planning and short term planning
26. AECO - Bookkeeping, journal, ledger, subsidiary books
27. AECO - Annual financial statements and taxation
28. AECO - Marketing management: Market, types, marketing assistance, market strat-

egies, business stake holders- Importance of agri-business in Indian economy
29. AECO - Supply Chain Management- Meaning, Advantages, Stages, Process, Drivers and Scope of Agri-Supply Chain Management
30. AEXT - Crisis management: Raw material, production, leadership, market, finance, naturals etc.
31. AEXT - Assessment of entrepreneurship skills - Business leadership skills- Communication skills for entrepreneurship development
32. AEXT - Organizational skills, managerial skills, problem solving skills, and time management skills for entrepreneurship development

Practicals

1. AEXT - SWOT analysis of a selected agro-based enterprise
2. AEXT - Visit to study the characteristics of successful entrepreneurs/agripreneurs
3. AEXT - Visit to Entrepreneurial Development Institute to study the process of Entrepreneurship Development
4. AEXT - Visit to study the constraints in setting up of Agro-industries/Micro Medium and Small Enterprises(MSMEs)
5. AECO - Visit to Agro-industry to study the formulation of Project feasibility Report
6. AECO - Visit to local financial institutions to study the MSME policies
7. AEXT - Visit to Institutions/agencies supporting entrepreneurship
8. AEXT - Visit to local public-private enterprise to study the enterprise management
9. AEXT - Visit to Agri-clinic and Agribusiness center
10. AEXT - Visit to Agri-export agency
11. AEXT - Practicing exercise on creativity and time audit
12. AECO - Practicing exercise on project report preparation and proposal writing
13. AEXT - Power point presentation of Assignments-Session I
14. AEXT - Power point presentation of Assignments-Session II
15. AEXT - Power point presentation of Assignments-Session III
16. AEXT - Power point presentation of Assignments-Session IV

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. Prasanna Chandra. 2012, Projects. TataMcGraw Hill, New Delhi
9. Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
10. Singhal, R.K. 2013, Entrepreneurship Development & Management, Katson Books.
11. Tripathi, P.C. and Reddy, P.N. 1991. Principles of Management. Tata McGraw Hill
12. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House

AEXT 292
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 programmes 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.

Course Outlines

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

Practicals

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.

Lecture Outlines

Theory

1. Education: meaning, definition & types; Extension education- meaning, definition, concepts, characteristics, scope and process, Objectives and principles of extension education
2. Extension programme planning - meaning, process, principles; Extension programme planning - steps in programme development.
3. Extension systems in India: Extension efforts in pre-independence era - (Srinikethan, Marthandam, Sevagram, Firka development scheme, Gurgaon experiment, etc.,) Extension efforts in post- independence era - Etawah pilot project, Nilokheri experiment etc.,
4. Reorganized Extension System (T&V system) various extension/ agricultural development programmes launched by ICAR / Govt. of India - IADP, IAAP, HYVP, KVK, IVLP.
5. Rural development- meaning, definitions, concept, various rural Development programs launched by Govt . of India
6. Community development- meaning, definition, concept and principles, philosophy of C.D.
7. New trends in agricultural extension- privatization extension and cyber extension/ e-extension, market-led extension, farmer - Led extension, expert systems, etc.,
8. DWCRA, Commodity Interest Groups (CIGs)., Farmer Producer Groups (FPG).
9. Transfer of technology: concept and models and capacity building of extension, extension personnel
10. Rural leadership : meaning, definition and concept, types of leaders in rural context, roles of leaders and methods of identification of a Rural leader
11. Extension administration: meaning, definition and concept, principles and functions. Monitoring evaluation - Definition and concept, principles. monitoring and evaluation of extension programmes
12. Extension Teaching Methods- meaning, classification, individual, group and mass contact methods.
13. ICT Applications in TOT (New and Social Media), media mix strategies.
14. Communication: meaning and definition; Principles and functions of Communication, Models and barriers in Communication.
15. Diffusion of Innovation: Concept and meaning process, attributes of innovation and stages of adoption, adopter categories.
16. Agriculture Journalism

Practicals

1. To study and familiarize university extension system
2. Group discussion - Simulated exercise
3. Identification of rural leaders in village situation
4. Preparation and use of Audio-visual Aids
5. Preparation of extension literature - Leaflet, folder, pamphlet, booklet, news stories and success stories
6. Presentation skills exercise

7. Visit to village to understand the problems being encountered by villagers/ farmers
8. Visit to study organization and functioning of DRDA/PRI other development departments at district level
9. Visit to NGO/FO/FPO and learning from their experience in rural development
10. Understanding PRA techniques and their application in village development planning
11. Visit to community radio
12. Visit to television studio
13. Developing script for print media
14. Developing script for electronic media
15. Developing script for radio
16. Developing script for Television

SEC XVII
VIDEO PRODUCTION
2 (0+2)

Lecture Outlines
Practical

1. Overview of Video Production- Importance- Introduction to the phases: Pre-production, Production, Post-production- Key roles in video production (Director, Producer, Cinematographer, Editor)
2. Visual Storytelling and Composition- The basics of visual storytelling, Camera angles, shots, and composition (rule of thirds, leading lines). Familiarization with camera, lighting, and audio equipment, Hands-on practice with shot composition and framing
3. Types of Video Project- Different genres of video (commercials, documentaries, narrative films), Target audience and video objectives.
4. Idea Generation and Concept Development- How to develop an idea for video content, Brainstorming and selecting video ideas.
5. Writing for Video: Scriptwriting- Basic principles of scriptwriting (story structure, character development), Script formatting. Writing a short 2-3 minute script, Peer review and script editing.
6. Storyboarding and Shot Lists - Translating a script into visuals, The importance of shot lists and storyboards in planning. Students create storyboards based on their short scripts, Discussion on shot selection and visual planning.
7. Budgeting and Scheduling for a Production- Creating production budgets and schedules, Location scouting, permits, and logistics. Students create a simple production plan for their short video projects.
8. Camera Operation and Settings- Understanding camera settings (ISO, shutter speed, aperture, white balance), Manual vs. automatic settings. Hands - on practice with camera settings, Shooting a simple scene using various settings.
9. Cinematography Techniques- Advanced camera movements (dolly, pan, tilt, zoom), The impact of lighting on mood and story. Students practice camera movements and creative shot compositions.
10. Lighting Fundamentals-Three- point lighting setup (key, fill, and backlight), Natural vs. artificial lighting.Setting up three-point lighting for a basic interview scene, Ex-

perimenting with lighting to create different moods.

11. Sound Recording and Microphones-Importance of good audio in video production, Different types of microphones (shotgun, lapel, boom). Recording clean audio in different environment, Experimenting with various microphones.
12. The Role of the Director- Responsibilities of a director, Communicating with actors and crew.
13. Directing Actors for Performance- Techniques for working with professional and non-professional actors, The director's role in shaping performances. Students direct a short scene with classmates as actors, Focus on actor performance and blocking.
14. Production Design and Art Direction-Importance of set design, costumes, and props, Visual coherence in storytelling.
15. Managing a Set-Organization on set: call sheets, production reports, time management, Problem- solving and maintaining the flow of production.Students design a simple set and manage a mock production environment.
16. Introduction to Video Editing- Basics of non-linear editing software (Adobe Premiere, Final Cut), Organizing and importing footage, Students edit their footage using basic cutting techniques and transitions.
17. Continuity Editing and Storytelling- Creating narrative flow through editing, Techniques like match cuts, jump cuts, and montage, Students refine their edits to ensure continuity in their projects
18. Advanced Editing Techniques-Working with pacing, rhythm, and emotional impact in editing, Layering visuals, sound, and music, Students use advanced techniques to enhance their projects.
19. Audio Editing and Mixing- Syncing audio with video, Balancing sound levels and removing noise, Students clean up audio, add music, and balance sound for their projects.
20. Music in Video Production- The role of music in creating mood and enhancing storytelling- Legal aspects: using licensed music vs. original scores, Students add music to their edited projects, focusing on timing and emotion
21. Introduction to Colour Correction- Basics of colour theory, Adjusting exposure, contrast, and colour balance, Students apply basic colour correction techniques to their projects.
22. Advanced Colour Grading - Using colour to create atmosphere and enhance narrative, Software tools for grading (DaVinci Resolve, Adobe Premiere),
23. Visual Effects (VFX) Basics- Understanding green screen techniques, compositing, and motion graphics. Incorporating VFX into Your Video - Simple special effects and how to integrate them with live-action footage.
24. Exporting and Encoding- Best practices for exporting high-quality video, Understanding video compression for different platforms, Students export their final videos using different settings.
25. AI Video Production: Chat GPT, Midjourney, Runway ML, etc.
26. Mobile Video Production - Mobile - related Video production tools, techniques and tips.
27. Platforms for Video Distribution- Uploading to YouTube, Vimeo, and other social platforms, Optimizing video for web distribution, Students develop a strategy for distributing their projects.

28. Marketing and Distributing Video Content- Basics of video marketing and search engine optimization (SEO), Reaching your target audience.
29. Advanced Camera Techniques- Using drones, slow motion, and time-lapse photography, Experimental techniques in cinematography.
30. The Future of Video Production- Emerging trends: virtual reality (VR), 360° video, live streaming.XR: Extended Reality, AR: Augmented Reality, MR: Mixed Reality. Also include AI Video Production.
31. Legal and Ethical Issues in Video Production- Copyright, intellectual property, and licensing, Ethical considerations in content creation
32. Final Project Presentation- Students present their final projects for critique and feedback

Suggested readings

1. Ascher, Steven, and Edward Pincus. The Filmmaker's Handbook: A Comprehensive Guide for the Digital Age. 5th ed., Plume, 2019.
2. Brody, Jessica. Save the Cat! Writes a Novel: The Last Book on Novel Writing You'll Ever Need. Ten Speed Press, 2018.
3. Brown, Blain. Cinematography: Theory and Practice: Image Making for Cinematographers, Directors, and Videographers. 3rd ed., Routledge, 2016.
4. Field, Syd. Screenplay: The Foundations of Screenwriting. Revised ed., Delta, 2005.
5. Field, Syd. The Screenwriter's Problem Solver: How to Recognize, Identify, and Define Screenwriting Problems. Delta, 1998.
6. Field, Syd. The Screenwriter's Workbook. Revised ed., Delta, 2006.
7. Hullfish, Steve. The Art and Technique of Digital Colour Correction. 2nd ed., Focal Press, 2013.
8. Jago, Maxim. Adobe Premiere Pro Classroom in a Book. Adobe Press, 2020.
9. Katz, Steven D. Shot by Shot: Visualizing from Concept to Screen. 25th Anniversary ed., Michael Wiese Productions, 2019.
10. Kenworthy, Christopher. Master Shots: 100 Advanced Camera Techniques to Get an Expensive Look on Your Low-Budget Movie. 2nd ed., Michael Wiese Productions, 2011.
11. Landau, David. Lighting for Cinematography: A Practical Guide to the Art and Craft of Lighting for the Moving Image. Bloomsbury, 2014.
12. Mamet, David. On Directing Film. Penguin Books, 1991.
13. Mascelli, Joseph V. The Five C's of Cinematography: Motion Picture Filming Techniques.Silman-James Press, 1998.
14. McKee, Robert. Story: Substance, Structure, Style and the Principles of Screen writing.ReganBooks, 1997.
15. Mercado, Gustavo. The Filmmaker's Eye: Learning (and Breaking) the Rules of Cinematic Composition. Focal Press, 2010.
16. Murch, Walter. In the Blink of an Eye: A Perspective on Film Editing. 2nd ed., Silman-James Press, 2001.
17. Rabiger, Michael. Directing: Film Techniques and Aesthetics. 5th ed., Focal Press, 2013.
18. Rodriguez, Robert. Rebel Without a Crew: Or How a 23-Year-Old Filmmaker with $7,000 Became a Hollywood Player. Plume, 1996.
19. Rose, Jay. Producing Great Sound for Film and Video. 4th ed., Focal Press, 2014.
20. Snyder, Blake. Save the Cat!: The Last Book on Screen writing You'll Ever Need. Mi-

chael Wiese Productions, 2005.
21. Trottier, David. The Screenwriter's Bible: A Complete Guide to Writing, Formatting, and Selling Your Script. 7th ed., Silman-James Press, 2019.
22. Viers, Ric. The Sound Effects Bible: How to Create and Record Hollywood Style Sound Effects. Michael Wiese Productions, 2008.

ELCT 491
AGRICULTURAL JOURNALISM
4 (3+1)

Objectives

1. To impart knowledge and skill in agricultural journalism

Course Outlines

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 art work (Graphs, charts maps, etc) Writing the captions Editorial mechanism: Copy reading, headline and Course Title writing Proof reading: definition, signs and symbols of proof reading, level of proof reading, duties ofa 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 art work for the agricultural story. Practice in editing, copy reading. Practice in headline and Course Title writing Practising proof reading. Practice in lay outing of newspaper. Testing copy with a readability formula. Visit a publishing office

Lecture Outlines

Theory

1. Journalism Meaning, nature, importance, and Types of journalism.

2. Agricultural Journalism, Meaning, definition, principle, objectives, types, and scope.
3. Similarities and difference between, Agricultural journalism and other types of journalism
4. Role of agricultural journalist, Qualities of journalist, role of journalist / journalism in agricultural development
5. Training of agricultural journalist on Agri technologies Agri Journalism
6. Development of newspaper and magazines readers
7. Newspaper as communication media: Characteristics, kinds and functions of newspaper
8. Characteristics of newspaper and magazine readers
9. Form, content, style and language of Newspaper and magazines, Standard part of newspaper and magazines.
10. The agricultural story: Types of agriculture stories, subject matter of the agricultural story, structure of the agricultural story.
11. Gathering farm information - Sources of farm information: Abstracting from research and scientific Materials, interviews, coverage of events.
12. Gathering farm information - Other sources: electronic media, field study.
13. Success story: Definition, nature, components, guidelines of writing a success story.
14. Writing a news story, difference between news and feature story.
15. The principle of writing a news story, Inverted pyramid structure.
16. Organizing the material, treatment of the story, writing the news lead and the body.
17. Readability Measure-readability ease score, automated readability index, gunning fog index,
18. Guidelines to improve Readability of articles and stories.
19. Basic principles of photography composition, exposure, lens, light.
20. Proof reading: Definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader. Editorial mechanism: Copy reading,
21. Illustrating agricultural stories: Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions in Agri journalism
22. Writing the captions. Headline and Course Title writing and importance in Agri journalism
23. Layout-Meaning, principles of layout and design of different Print media for Agri journalism
24. Case Studies in Agricultural Journalism-Impactful stories, success stories, lessons learnt.
25. A Theoretical orientation on videography for documentation
26. Principles and Guidelines in Script writing for Radio.
27. Principles and Guidelines in Script writing for Television
28. Digital Agricultural Journalism: Definition, scope, and significance in modern agriculture.
29. Evolution of Digital Media in Agricultural Journalism - Transition from traditional to digital media, impact on agriculture reporting.
30. Digital Journalism vs. Traditional Journalism-Key differences, benefits, and challenges in a digital context.
31. Agriculture Journalism services of SAU for Agricultural Development.
32. The Digital Journalist's Toolkit :- Essential digital tools for reporting, editing, and publishing

33. Writing for Digital Platforms- Adapting writing style for web audiences: brevity, clarity and SEO.
34. Structure and Formatting for Web Content- Inverted pyramid, bullet points, and paragraph spacing for readability. Incorporating Links and Hyper media effective linking, citation practices, and adding multimedia elements.
35. Writing for Social Media - Adapting agricultural stories for social platforms like Twitter, Facebook, and Instagram.
36. Blogging and Micro blogging in Agricultural Journalism- Platforms, styles, and strategies for blogging about agriculture.
37. Introduction to Multi media-The role of text, audio, video, and visuals in digitaljournalism.
38. Integrating Multimedia Elements into Digital Stories- How to combine text, images, audio, and video into cohesive stories.
39. Podcasting and Audio Content Creation- Creating and distributing audio content, including interviews and reports.
40. Understanding Social Media Platforms- Overview of major platforms and their unique characteristics.
41. Developing a Social Media Strategy for Agricultural Journalism- Identifying goals, target audiences, content types.
42. Basics of Digital Editing- Tools and techniques for editing digital content, including multimedia.
43. Basics of SEO for Agricultural Journalists Techniques for optimizing content for search engines. Writing for SEO without Sacrificing Readability - Balancing keyword usage with natural language.
44. Publishing and Promoting Content Online- Steps for publishing, distributing, and promoting digital content.
45. Emerging technologies in digital Journalism - AI, machine learning, Block chain and its applications in agricultural journalism.
46. Augmented Reality (AR)and Virtual Reality (VR) in Agricultural Journalism - Exploring immersive technologies and their potential uses.
47. Online Privacy and Data Security, - Protecting sources and personal information online. Handling Harassmentand Trolling Online- Strategies for maintaining professionalism and personal safety
48. Ethical Considerations in Digital Journalism - copy right plagiarism and maintaining integrity online. Dealing with Misinformation and fake News

Praticals

1. Practice in writing an agricultural news story/ Success story
2. Practice in writing an agricultural feature story/ popular article
3. Covering agricultural events for the information collection.
4. Practice in interviewing for the information collection
5. Abstracting stories from research and scientific materials and wire services.
6. Practice in script writing for Television
7. Practicing in script writing for Radio
8. Practicing proof reading. Practicing editing, copy reading.
9. Using metrics to assess engagement, reach, and influence. Analytics and measuring social media Success.
10. Podcasting and Audio Content Creation- Creating and distributing audio content,

including interviews and reports.
11. Integrating Multimedia Elements into Digital Stories- Editing - How to combine text, images, audio, and video into cohesive stories.
12. Testing copy with a readability formula.
13. Visit a publishing office documentation of process of agri journalism
14. Practice in writing for Digitals platforms ; Social Media and Blogging in Agricultural Journalism
15. Developing a Social Media Strategy for Agricultural Journalism- Identifying goals, target audiences, and content types.
16. Study and documentation of on Agric journalism services of SAU.

Suggested readings

1. Introduction to Journalism-Book by Carole Fleming, Emma Hemmingway, and Gillian Moore
2. Basic Journalism Book by Rangaswami Parthasarathy
3. News Reporting and Editing Book by K. M. Shrivastava
4. Professional Journalism Book by MV Kamath
5. The Journalist's Handbook Book by MV 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

AGRICULTURAL STATISTICS

STAM 101
INTRODUCTORY MATHEMATICS
1 (0+1)

Objectives

1. To acquaint student with the basics of Mathematics i.e., Progressions, matrices, Differentiation, Integration and Mathematical models.
2. To provide basic knowledge Mathematics which can be used in other subjects of Agriculture
3. To make students familiar with Mathematics applications in agriculture.

Lecture Outlines

Practical

1. Progressions - Introduction - Arithmetic, Geometric and Harmonic Progressions (nth term and sum of n-terms) and Problems
2. Matrices - Introduction, Definitions - Types- Addition- Subtraction - Multiplication (Upto 3rd order) and its examples
3. Transpose, Minor, cofactor, adjoint of matrices and Inverse of a matrix by adjoint method (Upto 3rd order) and problems
4. Properties of determinants up to 3rd order and simple problems
5. Differentiation - Introduction - derivative of xn , ex, sin x and cos x by first principle.
6. Derivatives rules on sum, difference, product and quotient of two functions - Simple problems based on it.
7. Derivative of a function of a function (chain rule), Logarithmic differentiations and problems.
8. Applications of Differentiation- Growth rate, Average cost, Marginal cost and Marginal Revenue and problems.
9. Increasing, Decreasing and Maxima and minima of a function y = f(x) and related problems
10. Partial differentiation- Introduction -Problems on partial differentiation of first and second orders.
11. Problems on Homogeneous function- Euler's theorem.
12. Indefinite Integrals- Introduction- and problems
13. Definite Integrals and problems
14. Integration of product of two functions - Integration by substitution and problems
15. Mathematical Models: Model Definition - Problems on fitting of Linear and quadratic on experimental data.
16. Mathematical Models - Problems on fitting of exponential models (on experimental data).

Suggested Readings

1. Engineering Mathematics-I by M. Vishnu Murthy, Falcon Publishers.
2. Engineering Mathematics-II by M. Vishnu Murthy, Falcon Publishers.
3. Text Book of NCERT Mathematics for X class.
4. MVSL DN Raju and K.V. Ramana - Agricultural Mathematics.
5. Fundamental Mathematical Statistics by S.C Gupta and V.K. Kapoor, Chand Series.

VAC 202
AGRICULTURAL INFORMATICS AND ARTIFICIAL INTELLIGENCE
3 (2+1)

Objectives

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

Course Outlines

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 adocument, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction general programming concepts, Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/ output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, 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-firstsearch, 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.

Practicals

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files & folders, File Management. Use of MS-WoRD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spread

sheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MSACCESS: 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 practiceon Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation ofinputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices inagro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, AR/VR demonstration, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Lecture Outlines

Theory

1. Introduction to Computers- Definition, Evolution of computers, Advantages and limitations.
2. Anatomy of Computers (with block diagram)- Components of computer and it's functions.
3. Overview of Input and output devices of Computer.
4. Computer memory concepts- Units of Memory- Primary memory and Secondary memory-RAM- ROM-PROM-EPROM-EAPROM-Cache memory.
5. Processors and Speed, Classifications of Computers, Hardware and Software.
6. Computer Languages- Machine, Assembly and High-level languages- Algorithm and flow charts.
7. Types of Software- Operating system - Translators- Interpreters - utility program - Application program, General Purpose program- Viruses and Vaccines.
8. Operating System (OS)- Functions of OS - Types of OS- DOS and Windows-Booting process
9. WINDOWS: Features of Windows OS, Desktop and its elements, Anatomy of a WINDOW - Course Title Bar, Minimize, Maximize, Restore and Close Buttons, Scroll Bars, Menus and Tool-Starting and shutting down of WINDOWS. WINDOWS Explorer, working with organization of files and folders, Copy, Move and Print files - Setting time and date.
10. Introduction to MS-Office and Applications. MS-Word: Features of good word processor. Creating, Editing and Formatting a document.
11. MS-Word: Toolbar options - Converting to .pdf files.
12. MS-Word: Equation editor, Drop cap, Format Painter, Auto text etc.
13. MS-Excel: Features, Data presentation, Tabulation, Sorting, Filtering, Merging of cells, etc.
14. MS-Excel: Creation of Diagrams and Graphs- pivot Table
15. MS-Excel: Solving of formula expressions through formula toolbar- In-built functions (Sum, Average, Standard deviation, Correlation. etc.) - Applications of Data Analysis tools- Introduction to Statistical analysis -Descriptive Statistics, Correlation and Regression.
16. MS-Excel: Data Analysis tools - t-test, z-test and ANOVA
17. Introduction of Database Management System. Applications of DBMS in Agriculture and other fields.
18. Introduction of MS-Access, Objects of MS-Access and types of fields.

19. MS-Access: Concepts and creating data base.
20. MS-PowerPoint: Creating slides, Layout, Action buttons, Transitions, Animations etc.
21. Networking - Types of networks (LAN, WAN, MAN, EAN etc.,)- networking equipments and Internet- World Wide Web (WWW)- Concepts
22. Introduction on e-Agriculture- Concepts of smart agriculture.
23. Application of innovative ways to use information and communication technologies (IT) in Agriculture.
24. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, advantages and limitations.
25. Smartphone mobile apps in agriculture for farm advice: Market price, post-harvest management etc.
26. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri- information.
27. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions.
28. Preparation of contingent crop planning and crop calendars using IT tools.
29. Digital India and schemes to promote digitalization of agriculture in India.
30. Introduction to Artificial Intelligence (AI)- Definition, background and its applications and limitations.
31. Use of AI in agriculture for autonomous crop management - Livestock health monitoring-Food and nutrition sciences. etc.
32. Introduction and applications of the Internet of Things (IoT) in agriculture and other sectors with examples- Role of Big Data analytics in Agriculture sector.

Practicals

1. Study of computer components, accessories - Booting of computer and its shut down - Practicing Windows operating system - Course Title bar - Minimum, maximum and close buttons - Scroll bars Menus and tool bars.
2. DOS Commands - DATE, TIME, DIR, COPY, PATH, LABEL, VOL, MD, CD, DEL and TREE etc.,
3. Windows explorer-creating files and folders, File Management, Control Panel-Taskbar and desktop management- Paint, notepad, wordpad, calculator etc.,
4. MS-Word: Menu bar, creating a document, saving and editing etc.
5. MS-Word: Creation of tables, Equation editor, Drop cap, Format Painter, mail merge
6. MS-PowerPoint: Creating slides, editing (Layout, action buttons...etc.) and power-point presentation.
7. MS- Excel: Creating a spread sheet and data entry- Basic Functions (Mathematical and Statistical) through formula bar and use of in-built functions. Sorting-Filtering and Text to column.
8. MS- Excel- RBD Analysis using cell reference
9. MS- Excel: Pivot table, Creating diagrams and graphs, What if analysis etc.,
10. MS- Excel: Analysis of scientific data- Data Analysis tools- Descriptive Statistics (Mean, Median, Mode. Etc.), Histogram, Correlation and Regression
11. MS- Excel: Data Analysis tools- Testing of hypothesis (t-test, z-test, F-test), ANOVA one way and ANOVA two-way classification.
12. MS-Access: Creating Database by structuring with different types of fields and Cre-

ating relationships.
13. MS-Access: Preparing queries and report.
14. Introduction to World Wide Web (WWW)- Internet concepts - Creating Email - use of Search Engines.
15. Use of smart phones and other devices in Agro-advisory and dissemination of market information.
16. GIS Applications in Agriculture

Suggested Readings

1. Fundamentals of Computers by V. Rajaraman
2. Introduction to Information Technology by Pearson
3. An Introduction to Database Systems by C. J. Date
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan Satpathy, Wiley India
5. Introductory Agri Informatics by Subrat K. Mahapatra et al., Jain Brothers Publication
6. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, Pearson (2013)
7. Principles of Artificial Intelligence by Nils J. Nilsson, Narosa Publishing House (2001)

STAM 301
BASIC AND APPLIED AGRICULTURAL STATISTICS
3 (2+1)

Objectives

1. To provide basic knowledge of Statistics and its applications in Agriculture
2. To make students familiar with Tools of Statistics for data Analysis and interpretations.
3. To make students to draw meaningful conclusions from the experimental data.

Course Outlines

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. ofclass 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 Measuresof 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 andGrouped 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 oneway classification. CRD. Selection of random sample using simple random sampling.

Lecture Outlines

Theory

1. Introduction and various definitions of Statistics - limitations, importance and Applications in Agriculture
2. Types of Data (primary data secondary data), types of variables (discrete and continuous), Scales of measurements of Data (nominal, ordinal, interval and ratio)
3. Classification, methods of classification (quantitative & qualitative) - Tabulation - parts of a table - frequency distribution (Construction of frequency table), types of frequency distributions (discrete and continuous).
4. Diagrammatic representation of Data - Bar Diagrams - Simple, Multiple, Sub-divided and Percentage Bar Diagrams, Pie-diagram
5. Graphical Presentation of Data - Histogram, Frequency curve and frequency Polygon and Ogives (cumulative frequency) curves
6. Measures of Central Tendency - Requisites for an Ideal Measure of Central

Tendency. Arithmetic mean, weighted mean, properties, merits, demerits and uses
7. Median, mode, geometric mean, Harmonic mean - merits & Demerit, empirical relationship between mean, median and mode; relationship between A.M., G.M. and H.M.
8. Measures of Dispersion - Characteristics for an Ideal Measure of Dispersion - list of Measures of Dispersions
9. Definition of Range, coefficient of range - Quartile Deviation - coefficient of Q.D and Mean Deviation.
10. S.D. and Variance for Grouped and Ungrouped Data - properties - Variance of Combined Series - Coefficient of dispersion, Co-efficient of Variation
11. Moments - skewness - kurtosis - different types and measures - Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution
12. Introduction to Probability - Basic Terminologies - event, set, types of events, permutations, combinations
13. Classical Probability- Definition and Limitations - Empirical Probability Definition and Limitations - Axiomatic Probability.
14. Addition and Multiplication Theorems - Conditional Probability, Baye's theorem
15. Normal Distribution- Definition, Probability density function, characteristics of normal distribution, Normal Probability Curve - Importance
16. Definition of correlation, types of correlations with examples and figures (scatter diagram), properties of correlation coefficient, Testing of correlation coefficient
17. Regression - fitting of linear regression equations of Y on X and X on Y
18. Properties of regression coefficients, testing of regression coefficients, inter relationship between r, b & b1
19. Tests of hypothesis - Null and Alternative Hypothesis. Type I and Type II Errors. Critical Region, Level of Significance, Parameter, statistic, degrees of freedom and S.E.
20. One tailed and two tailed tests, z-test for one sample and two samples
21. Small sample tests - one sample t-test and two sample t-test
22. Paired t-test and F-test
23. Chi square test - goodness of fit, applications, uses, yate's correction for continuity, 2x2 contingency table
24. Definitions of ANOVA, assumptions of ANOVA, assignable causes and random causes
25. Analysis for one way classification and two way classification
26. Uniformity trials - maximum curvature method, Fair field smith variance law
27. Design of experiments - blocks, treatments, experimental error, critical difference and Basic principles of experimental designs
28. Completely Randomised Design (CRD) layout and analysis with equal and unequal repetitions, advantages and disadvantages, applications
29. Randomised Block Design (RBD) - layout, analysis, advantages and disadvantages, applications
30. Latin square design (LSD) - Layout, analysis, advantages and disadvantages, applications
31. Introduction to sampling - population, sample, sampling error, sampling frame, sampling Vs complete enumeration
32. Simple random sampling - SRSWR & SRSWOR - estimates of population mean,

variance and its confidence limits; methods of selection of random sample

Practicals

1. Diagrammatic Presentation of Data. Bar Diagrams - Simple, Multiple, Sub-divided and Percentage Bar Diagrams, Pie-diagram
2. Graphical Presentation of Data - Histogram, Frequency curve and frequency Polygon and Ogives curves
3. Construction of Frequency Distribution table
4. Computation of Arithmetic Mean for Grouped and Un-grouped data (direct and step deviation method)
5. Computation of Median and mode for Grouped and Un-grouped data
6. Computation of Geometric mean and harmonic mean for grouped and ungrouped data
7. Computation of Q.D, M.D for grouped and ungrouped data
8. Computation of Standard Deviation, variance and CV for grouped and ungrouped data
9. Problems on addition - multiplication theorems and Baye's theorem
10. Student's t-test for single and two samples
11. Paired t-test and F-test
12. Computation of correlation coefficient and its testing
13. Fitting of simple regression equations Y on X and X on Y
14. Completely Randomized Design: Analysis with equal and unequal replications
15. Randomized Block Design: Analysis
16. Simple random sampling

Suggested readings

1. Fundamentals of Statistics by D. N. Elhance, KitabMahal 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. A Textbook on Statistics for Agricultural Sciences by V Srinivasa Rao, V V Krishna and G. Mohan Naidu, VGS Techno Series.
5. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House
6. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers
7. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers

ANIMAL HUSBANDRY

LSPM 101
LIVESTOCK AND POULTRY MANAGEMENT
2 (1+1)

Objectives

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

Course Outlines

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 feed stuffs. 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 andpoultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipments. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

Lecture Outlines

Theory

1. Role of livestock in the national economy.
2. Reproduction in farm animals and poultry.
3. Housing principles, space requirements for different species of cattle, buffalo, sheep, goat and poultry.
4. Management of calves, growing heifers and milch animals.
5. Management of sheep, goat and swine.
6. Incubation, hatching and brooding. Management of growers and layers.
7. Important indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry.
8. Improvement of farm animals and poultry.
9. Digestion in cattle, buffalo, sheep, and goat and poultry.
10. Classification of feed stuffs. Proximate principles of feed.
11. Nutrients and their functions.
12. Feed ingredients for ration for cattle, buffalo, sheep, and goat and poultry.

13. Feed supplements and feed additives.
14. Feeding of cattle, buffalo, sheep, and goat and poultry.
15. Introduction of cattle, buffalo, sheep, and goat and poultry diseases.
16. Prevention and control of important diseases of cattle, buffalo, sheep, goat and poultry.

Practicals

1. External body parts of cattle, buffalo, sheep, goat, swine and poultry.
2. Handling and restraining of cattle, buffalo, sheep, and goat.
3. Identification methods of farm animals and poultry.
4. Visit to dairy and poultry farms
5. Study of breeds of cattle, buffalo, sheep, goat and poultry
6. Daily routine farm operations and farm records.
7. Judging of cattle, buffalo and poultry.
8. Culling of cattle, buffalo, sheep, and goat and poultry.
9. Planning and layout of housing for different types of cattle, buffalo, sheep, goat and poultry.
10. Computation of rations for cattle, buffalo, sheep, goat and poultry.
11. Formulation of concentrate mixtures.
12. Clean milk production, milking methods.
13. Hatchery operations, incubation and hatching equipment.
14. Management of chicks, growers and layers.
15. Debeaking, dusting and poultry vaccination.
16. Economics of cattle, buffalo, sheep, goat, swine and poultry enterprises.

Suggested Reading

1. D. N. Verma 2005 A text book of livestock production management in tropic. kalyani publishers; 1st edition.
2. G. C Banerjee 2019 A textbook of animal husbandry. Oxford; 8th edition.

STUDENTS WELFARE

NSS I

NATIONAL SERVICE SCHEME - I

1 (0+1)

Objective

1. Introduction and basic components of NSS, NSS programmes and activities, Understanding youth, Community mobilization, social harmony and national integration, Volunteer is mandshramdan, Citizenship, constitution and human rights, Family and society.

Practical Activities

1. Orientation-History, objectives, principles, symbol and badge
2. Organizational structure of NSS, basic components of NSS-code of conduct for NSS volunteer's, points to be considered by NSS volunteer's awareness about health.
3. NSS programme sand activities - Concept of regular activities.
4. Special camping, day camps, basis of adoption of villages/slums.
5. Conducting survey, analyzing financial patterns of the scheme.
6. Youth programme / schemes of GOI, coordination with different agencies and maintenance of diary.
7. Understanding youth - definition, profile, categories, issues and challenges of youth; opportunities for youth who is agent of the social change.
8. Community mobilization-mapping of communitys take holders, designing the message as per problems and their culture.
9. Identifying methods of mobilization, involving youth-adult partnership.
10. Social harmony and national integration.
11. Indian history and culture, role of youth innation building, conflictre solution and peace-building.
12. Volunteerism and shramdan - Indian tradition of volunteerism, its need, importance, motivation and constraints.
13. Shramdan as part of volunteerism.
14. Citizenship, constitution and human rights - basic features of constitution of India, fundamental rights and duties.
15. Human rights, consumer awareness and right to information
16. Family and society-Concept of family, community (PRIs and other community based organisations) and society.

References:

1. Kartar Singh, Anil Shisodia 2024. Rural development principles, policies and management. Fourth edition by Atlantic publishers and distributors (P) ltd. New delhi.
2. Linda Mc. and Sarah Cunningham B 2024. Family in Society. Boundaries and relationships. Published by Bristol University Press, U.K.
3. Mathur R. C. 1951. Indian history and culture of the Indian people. Published by Bharatiya Vidya Bhavan, Mumbai.
4. National service scheme manual (revised) 2006,Government of India, Ministry of Youth affairs and Sports, New Delhi.

NSS II
NATIONAL SERVICE SCHEME - II
1 (0+1)

Objective

1. To evoke social consciousness among students through various activities viz., working together, con- structive, and creative social work, to be skilled in executing democratic leadership, developing skill in pro- gram, to be able to seek self-employment, reducing gap between educated and uneducated, increasing aware- ness and desire to help sections of society.

Practical/ Awareness activities

- 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.

Lecture Outlines

Practicals

1. Importance and role of youth leadership, Meaning, types and traits of leadership
2. Qualities of good leaders; importance and roles of youth leadership
3. Life competencies - Definition and importance of life competencies
4. Problem-solving and decision-making
5. Interpersonal communication.
6. Youth development programs - Development of youth programs and policy at the national level, state level and voluntary sector
7. Youth-focused and youth-led organizations
8. Health, hygiene and sanitation
9. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health.
10. National health programs and reproductive health
11. Youth health, lifestyle, HIV AIDS and first aid
12. Healthy lifestyles, HIV AIDS
13. Drugs and substance abuse
14. Home nursing and first aid
15. Youth and yoga - History, philosophy, concept, myths, and misconceptions about yoga
16. Yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

NCC I
NATIONAL CADET CORPS - I
1 (0+1)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

1. Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline
2. Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
3. Sizing, numbering, forming in three ranks, open and close order march, and dressing
4. Saluting at the halt, getting on parade, dismissing, and falling out.
5. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, paceforward and to the rear. Turning on the march and wheeling. Saluting on the march.
6. Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
7. Command and control, organization, badges of rank, honors, and awards.
8. Nation Building- cultural heritage, religions, traditions, and customs of India.
9. National integration. Values and ethics, perception, communication, motivation, decision making,discipline and duties of good citizens.
10. Leadership traits, types of leadership. Character/personality development.
11. Civil defense organization, types of emergencies, firefighting, protection.
12. Maintenance of essential services, disaster management, aid during development projects.
13. 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.
14. Structure and function of human body, diet and exercise, hygiene and sanitation.
15. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.
16. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NCC II
NATIONAL CADET CORPS - II
1 (0+1)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

1. Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out.
2. 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 trailfrom the order and vice- versa.
3. Guard mounting, guard of honor, Platoon/Coy Drill.
4. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting.
5. Rifle Loading, cocking, and unloading. The lying position and holding.
6. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
7. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
8. Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
9. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types ofbearings and use of service protractor. Prismatic compass and its use.
10. Setting a map, finding north and own position. Map to ground and ground to map.
11. Knots and lashings Comouflage and concealment, Explosives and IEDs.
12. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction.
13. Judging distance-Description of ground and indication of landmarks- Recognition and description of target - Observation, Camouflage and concealment.
14. Field signals and Section formations.
15. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
16. Types of communication, media, latest trends and developments.

COCA 201
PHYSICAL EDUCATION, FIRST AID, YOGA PRACTICES AND MEDITATION
2 (0+2)

Objectives

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

Practicals

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

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga

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

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First aid Techniques, First aid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Practicals

1. Introduction about the development - Uses of Physical Education - level of tournaments conducted in ANGRAU and College - How many games & sports to be taught

for boys& girls separately - Importance of Physical Education.
2. Training and Coaching - Meaning and Concept.
3. Methods of Training.
4. Aerobic and Anaerobic exercises.
5. Calisthenics - demonstration, Explanation and practice.
6. Weight training - Introduction & practice.
7. Circuit training - Introduction & practice.
8. Interval training - Introduction & practice.
9. Fartlek training - Introduction & practice.
10. Effects of Exercise on Muscular & Respiratory systems.
11. Effects of Exercise on Circulatory and Digestive systems.
12. Balanced Diet and Nutrition: Effects of Diet on Performance.
13. Physiological changes due to ageing and role of regular exercise on ageing process.
14. Personality, its dimensions and types.
15. Role of sports in personality development; Motivation and Achievements in Sports.
16. Learning and Theories of learning; Adolescent Problems and its Management.
17. Posture - Postural Deformities - Exercises for good posture.
18. Yoga; History of Yoga.
19. Types of Yoga, Introduction to Yoga.
20. Asanas: Definition and Importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan,Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan,
21. Asanas - Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan, left leg, right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan.
22. Suryanamskar - Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
23. Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh.
24. Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
25. Role of yoga in sports - Teaching of Asanas - Demonstration, practice, correction and practice.
26. History of sports and ancient games, Governance of sports in India; Important national sporting events.
27. Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style.
28. Coaching of major games (Cricket, football, Table Tennis, Badminton, Chess & Caroms
29. Coaching of major games (Volleyball, Basketball, Ball Badminton, Tennikoit,) and Athletics.
30. First Aid- Need and requirement - 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.
31. 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 transp ort of injured traumatized persons.

32. Sports injuries and their treatments.

Suggested Readings:

1. Sports Training - Dr.Dhananjay Shaw.
2. Sports Training - Dr.A.K.Uppal.
3. Aerobics Fitness & Style - Agarwal,M.
4. Physiology of Sport - Sivaramakrishnanan,S.
5. Sports Nutrition and Health - Anderson,H.S.
6. Group Dyanamics -Bonner.H.
7. Sports Psychology and training - Khanna,G.L.
8. Teaching of Yoga - Sharma,J.P.
9. Encyclopedia of Yoga - Sharma,H.L.
10. Health and Yoga - Malik,A.K.
11. The Yoga Sutras of Pathanjali - Johnston,C.
12. Book of Games - Hebbert,E.N.
13. Sports Medicine - Valavan,V.M.
14. Sports Injuries and Rehabilitation - Govindarajulu,N.
15. Book of Rules of Games and Sports - Chakravar,P.S.


ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY
113th MEETING OF THE
ACADEMIC COUNCIL
Dt:08-10-2024


ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY
Lam, Guntur, Andhra Pradesh
114th MEETING OF THE
ACADEMIC COUNCIL

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