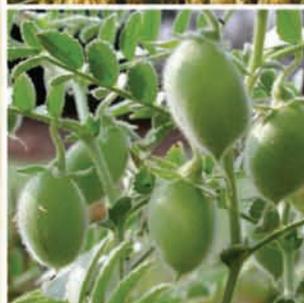
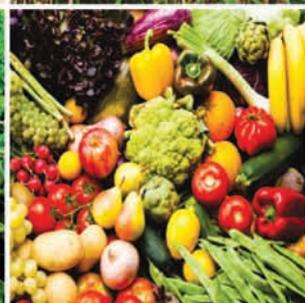
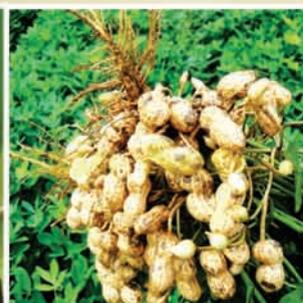


# CATALOGUE OF UNDER GRADUATE COURSE

B.Sc. (Hons) Agriculture  
2016



**ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY**

Lam, Guntur - 522 034



**Meeting on Revision of the Under Graduate (B.Sc. (Hons) Agriculture) Syllabus held at Agricultural College, Bapatla on 5.10.2016**

# **DETAILED LECTURE OUTLINES**

(as per V Deans Committee Recommendations)

## **B.Sc. (Hons) Agriculture**

**2016**

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Lam, Guntur - 522 034

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## FOREWORD

Major segment of population in our Country depend on Agriculture for their livelihood directly or indirectly. Realizing the importance of Agriculture, the Govt. of India has supported Agriculture Research and Education through successive year plans thereby could able to achieve green revolution lead to significant impact on our agriculture production resulting in feeding millions of population comfortably. The human resource developed through agricultural education has been primarily responsible for the green revolution in agriculture. However climate change, environmental pollution, changes in the pest scenario, production of healthy food and many more are challenging the scientists to search for suitable alternatives in agricultural practices for achieving sustainable production.

In order to have quality assurance in agricultural education, Indian Council of Agricultural Research has initiated steps to revise Under Graduate Course Syllabi. As a part of this the Vth Deans committee has submitted its report and ICAR has initiated steps to adopt the recommendations by all SAUs in the Country. Accordingly the ANGRAU has initiated steps to make changes as per our requirements in the syllabi proposed by Vth Deans Committee duly incorporating the important topics related Climate change, Sustainable Agriculture, Organic Agriculture, Natural Farming, Environmental Pollution, Disaster Management etc. Efforts were also made to train students towards employment generation by motivating them towards entrepreneurship through Students READY programme and Student Fests "Agricarnival". Steps were also initiated to strengthen our RAWE programme duly training them through Farmers trainers and other progressive farmers' clusters. I should congratulate the efforts made by the Dean of Agriculture, his team and all the Teachers involved in developing the course curriculum for the Under Graduate Course B.Sc. (Hons) Agriculture to be implemented from 2016 onwards which only brings uniformity and also provides opportunity to the students to achieve their goals.

Place : Guntur

Date : 1<sup>st</sup> December, 2016

**(B. RAJSEKHAR)**

**Dr. Tatineni Ramesh Babu**

Dean of Agriculture



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## PREFACE

Agriculture is the backbone of the country and majority of the population is directly or indirectly involved in Agriculture. Everybody should agree that the Agriculture Education is the primary component involved in the development of agriculture after independence. The Indian Council of Agriculture Research (ICAR) is the apex body in the country involved in guiding the Research, Teaching and Extension components. As a part of course curriculum development the ICAR has published the V Deans Committee recommendations for the course curriculum for Under Graduate Course (B.Sc. (Hons) Agriculture) in Agriculture.

After release of the V Deans Committee recommendations, the Acharya N.G. Ranga Agricultural University has conducted several discussions involving all the faculty working in all the five colleges to fine tune the course curriculum duly following the V deans Committee recommendations to suit the agriculture, latest developments in agriculture and the problems faced by the agriculture in the state of Andhra Pradesh. The efforts were made keeping in view of the latest developments in Agriculture and steps lead the sustainable agriculture. For the first time the feedback and suggestions from Progressive Agriculturalists and NGO's were also considered for the improvement of content that too, the practical component. The syllabus was designed to enhance the personality of the students, to motivate the students towards innovative thinking and also to inculcate the students towards the entrepreneurship. I hope that this book is highly useful to the staff, students and academicians to bring uniformity among the colleges to adopt common course outlines.

I express my sincere thanks to the Hon'ble Vice – Chancellor Sri. B. Rajsekhar, IAS for his constant support for bringing out this book. I congratulate and express my deep sense of thanks to all the University Officers, Associate Deans, University Heads of all departments, staff of all the five colleges i.e., Agricultural College, Bapatla; S.V. Agricultural College, Tirupati; Agricultural College, Naira; Agricultural College, Mahanandi; Agricultural College, Rajamahendravaram and Advanced Post Graduate Centre, Guntur for their efforts in developing the course curriculum for the under Graduate Course (B.Sc. (Hons) Agriculture) in the Faculty of Agriculture. I wish all the best to all the students who will undergo the course.

Date: 01-12-2016  
Place: Guntur

**(T. RAMESH BABU)**

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**&  
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## YEAR WISE AND SEMESTER WISE DISTRIBUTION OF CREDITS AMONG DIFFERENT DEPARTMENTS

S.No	Department	First year		Second year		Third year		Total credit hours (up to third year)		
		I	II	I	II	I	II	Theory	Practical	Total
1.	Agronomy	<u>101*</u> 1+0 <u>102</u> 2+1	<u>103</u> 1+1 <u>104</u> 1+1	<u>201</u> 2+1	<u>202</u> 2+1 <u>203</u> 1+0 <u>204</u> 1+1	<u>301</u> 1+1 <u>302</u> 0+1	<u>303</u> 1+1 <u>304</u> 1+1	14	10	24
2.	Genetics and Plant Breeding		<u>111</u> 2+1	<u>211</u> 2+1		<u>311</u> 1+1 <u>313</u> 1+0	<u>312</u> 1+1 <u>314</u> 2+1	9	5	14
3.	Soil Science and Agricultural Chemistry	<u>121</u> 2+1			<u>221</u> 2+1	<u>321</u> 1+1		5	3	8
4.	Entomology		<u>131</u> 2+1	<u>231</u> 1+1		<u>331</u> 2+1	<u>332</u> 2+1	7	4	11
5.	Agricultural Economics	<u>141</u> 3+0		<u>241</u> 1+1	<u>242</u> 2+1		<u>341</u> 1+1	7	3	10
6.	Agricultural Engineering		<u>151</u> 1+1	<u>251</u> 1+1	<u>252</u> 1+1	<u>351</u> 1+1		4	4	8
7.	Crop Physiology	<u>161*</u> 1+1	<u>162</u> 2+1	<u>261</u> 1+1		<u>361</u> 1+1		5	4	9
8.	Plant Pathology		<u>171</u> 2+1	<u>271</u> 1+1		<u>371</u> 2+1 <u>373</u> 1+1	<u>372</u> 1+1	7	5	12
9.	Horticulture	<u>181</u> 1+1	<u>182</u> 1+1	<u>281</u> 1+1	<u>282</u> 1+1		<u>381</u> 1+1	5	5	10
10.	Agricultural Extension	<u>190**</u> 1+0 <u>191</u> 1+1		<u>291</u> 2+1	<u>292</u> 1+1		<u>391</u> 1+1	6	4	10
11.	Bio-Chemistry Biotechnology	<u>101</u> 2+1				<u>300</u> 2+0		4	1	5
12.	Livestock and Poultry Management				<u>201</u> 2+1					
13.	Agricultural Microbiology		<u>101</u> 1+1					1	1	2
14.	Statistics and Computer Applications	<u>101*</u> 1+1			<u>201</u> 1+1		<u>301</u> 1+1	3	3	6
15.	English	<u>101</u> 1+1						1	1	2
16.	Physical Education	<u>100</u> 0+2		<u>200</u> 0+2				0	2	2
	<b>TOTAL CREDITS</b>	<b>24</b> <b>(15+9)</b>	<b>22</b> <b>(13+9)</b>	<b>23</b> <b>(12+11)</b>	<b>23</b> <b>(14+9)</b>	<b>22</b> <b>(13+9)</b>	<b>22</b> <b>(12+10)</b>	<b>79</b>	<b>57</b>	<b>136</b>
17.	Elective Courses				<u>222</u> 1+2 (or) <u>272</u> 2+1 (or) <u>283</u> 2+1 (or) <u>382</u> (2+1)	<u>305</u> (2+1) (or) <u>333</u> (2+1) (or) <u>342</u> (2+1) (or) <u>362</u> (1+2) (or) <u>382</u> (2+1)	<u>306</u> (2+1) (or) <u>315</u> (1+2) (or) <u>334</u> (2+1) (or) <u>383</u> (2+1)	<b>9 Credits</b>		9
	<b>TOTAL</b>	<b>24</b> <b>(15+9)</b>	<b>22</b> <b>(13+9)</b>	<b>23</b> <b>(12+11)</b>	<b>23</b> <b>(14+9)+</b> <b>3 Credits</b>	<b>22</b> <b>(13+9)+</b> <b>3 Credits</b>	<b>22</b> <b>(12+10)+</b> <b>3 Credits</b>	<b>79</b>	<b>57</b>	<b>145</b>
<b>Fourth Year – First Semester: Rural Agricultural Work Experience (RAWEx) and Agro Industrial Attachment (AIA)</b>								<b>0</b>	<b>20</b>	<b>20</b>
<b>Fourth Year - Second Semester: Experiential Learning Programme (ELP) / Hands on Training (HOT)</b>								<b>0</b>	<b>20</b>	<b>20</b>
<b>GRAND TOTAL</b>										<b>185</b>

\* Remedial \*\* Non gradial

## DEPARTMENT WISE DISTRIBUTION OF COURSES

S. No.	Course No.	Department and Title of Course	Credits
<b>AGRONOMY</b>			
1.	AGRO 101	Agriculture Heritage*	1(1+0)*
2.	AGRO 102	Fundamentals of Agronomy	3(2+1)
3.	AGRO 103	Introductory Agrometeorology and Climate Change	2 (1+1)
4.	AGRO 104	Introduction to Forestry	2 (1+1)
5.	AGRO 201	Crop Production Technology – I ( <i>Cereals, Millets and Pulses</i> )	3 (2+1)
6.	AGRO 202	Crop Production Technology –II ( <i>Oilseeds, Fibre, Sugar, Tobacco and Fodder crops</i> )	3 (2+1)
7.	AGRO 203	Farming Systems and Sustainable Agriculture	1 (1+0)
8.	AGRO 204	Irrigation Water Management	2 (1+1)
9.	AGRO 301	Geoinformatics and Nanotechnology for Precision Farming	2 (1+1)
10.	AGRO 302	Practical Crop Production	1 (0+1)
11.	AGRO 303	Rainfed Agriculture & Watershed Management	2(1+1)
12.	AGRO 304	Principles of Organic Farming	2(1+1)
<b>Total</b>			<b>24(14+10)</b>
<b>GENETICS AND PLANT BREEDING</b>			
1.	GPBR 111	Fundamentals of Genetics	3(2+1)
2.	GPBR 211	Fundamentals of Plant Breeding	3 (2+1)
3.	GPBR 311	Crop Improvement-I ( <i>Cereals, Millets, Pulses and Oilseeds</i> )	2 (1+1)
4.	GPBR 312	Crop Improvement-II ( <i>Fibres, Sugars, Starches, Narcotics, Vegetables, Fruits and Flowers</i> )	2 (1+1)
5.	GPBR 313	Intellectual Property Rights	1(1+0)
6.	GPBR 314	Principles of Seed Technology	3 (2+1)
<b>Total</b>			<b>14(9+5)</b>
<b>SOIL SCIENCE AND AGRICULTURAL CHEMISTRY</b>			
1.	SSAC 121	Fundamentals of Soil Science	3(2+1)
2.	SSAC 221	Manures, Fertilizers and Soil Fertility Management	3(2+1)
3.	SSAC 321	Problematic Soils and their Management	2(1+1)
<b>Total</b>			<b>8(5+3)</b>
<b>ENTOMOLOGY</b>			
1.	ENTO 131	Fundamentals of Entomology I (Insect Morphology and Taxonomy)	3(2+1)
2.	ENTO 231	Fundamentals of Entomology II (Insect Ecology and Concepts of IPM)	2(1+1)
3.	ENTO 331	Pests of Field crops & Stored Grain and their Management	3 (2+1)

4.	ENTO 332	Pest of Horticultural Crops and their Management and Beneficial insects	3(2+1)
<b>Total</b>			<b>11(7+4)</b>

### AGRICULTURAL ECONOMICS

1.	AECO 141	Fundamentals of Economics	3(3+0)
2.	AECO 241	Agricultural Finance and Co-operation	2 (1+1)
3.	AECO 242	Agricultural Marketing, Trade and Prices	3 (2+1)
4.	AECO 341	Farm Management, Production and Resource Economics	2 (1+1)
<b>Total</b>			<b>10(7+3)</b>

### AGRICULTURAL ENGINEERING

1.	AENG 151	Soil and Water Conservation Engineering	2(1+1)
2.	AENG 251	Farm Machinery and Power	2 (1+1)
3.	AENG 252	Renewable Energy and Green Technology	2 (1+1)
4.	AENG 351	Protected Cultivation and Post-harvest technologies	2 (1+1)
<b>Total</b>			<b>8(4+4)</b>

### CROP PHYSIOLOGY

1.	CPHY 161	Introductory Biology*	2(1+1)*
2.	CPHY 162	Fundamentals of Crop Physiology	3(2+1)
3.	CPHY 261	Eco-physiology	2(1+1)
4.	CPHY 361	Environmental Studies and Disaster Management	2(1+1)
<b>Total</b>			<b>9(5+4)</b>

### PLANT PATHOLOGY

1.	PATH 171	Fundamentals of Plant Pathology I (Plant Pathogens – An Introduction)	3(2+1)
2.	PATH 271	Fundamentals of Plant Pathology II (Plant Pathology Principles)	2(1+1)
3.	PATH 371	Diseases of Field and Horticultural Crops and their Management -I (Field Crops)	3 (2+1)
4.	PATH 372	Diseases of Field and Horticultural Crops and their Management-II (Horticultural Crops)	2 (1+1)
5.	PATH 373	Principles of Integrated Pest and Disease Management	2(1+1)
<b>Total</b>			<b>12(7+5)</b>

### HORTICULTURE

1.	HORT 181	Fundamentals of Horticulture	2 (1+1)
2.	HORT 182	Production Technology of Fruits and Plantation Crops	2 (1+1)
3.	HORT 281	Production Technology for Vegetables and Spices	2 (1+1)
4.	HORT 282	Production Technology for Ornamental Crops, Medicinal & Aromatic Plants and Landscaping	2 (1+1)

5.	HORT 381	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
<b>Total</b>			<b>10(5+5)</b>

### AGRICULTURAL EXTENSION

1.	AEXT 190	Human Values & Ethics (non gradial)	1(1+0)**
2.	AEXT 191	Rural Sociology & Educational Psychology	2 (1+1)
3.	AEXT 291	Fundamentals of Agricultural Extension	3(2+1)
4.	AEXT 292	Entrepreneurship Development and Business Communication	2(1+1)
5.	AEXT 391	Communication Skills and Personality Development	2(1+1)
<b>Total</b>			<b>10(6+4)</b>

### BIOCHEMISTRY AND BIOTECHNOLOGY

1.	BICM 101	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
2.	BICM 300	Principles of Food Science and Nutrition	2(2+0)
<b>Total</b>			<b>5(4+1)</b>

### ANIMAL PRODUCTION

1.	LSPM 201	Live-stock and Poultry Management	3 (2+1)
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### AGRICULTURAL MICROBIOLOGY

1.	AMBE 101	Agricultural Microbiology	2(1+1)
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### STATISTICS AND COMPUTER APPLICATIONS

1.	SMCA 101	Elementary Mathematics*	2(1+1)*
2.	SMCA 201	Statistical Methods	2(1+1)
3.	SMCA 301	Agriculture Informatics	2(1+1)
<b>Total</b>			<b>6(3+3)</b>

### ENGLISH

1.	ENGL 101	Comprehension & Communication Skills in English	2 (1+1)
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### PHYSICAL EDUCATION

1.	COCA 100	NSS/NCC/Physical Education & Yoga Practices**	2 (0+2)**
2.	COCA 200	Education Tour**	2 (0+2)**
<b>Total</b>			<b>4 (0+4)**</b>

### ELECTIVE COURSES

#### AGRONOMY

1.	ELCT 305	Agricultural Waste Management	3(2+1)
2.	ELCT 306	Weed Management	3(2+1)

### **GENETICS AND PLANT BREEDING**

3. ELCT 315 Commercial Plant Breeding 3(1+2)

### **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**

4. ELCT 222 Soil, Plant, Water and Seed Testing 3(1+2)

### **ENTOMOLOGY**

5. ELCT 333 Bio pesticides and Bio fertilizers 3(2+1)

6. ELCT 334 Agrochemicals 3(2+1)

### **AGRICULTURAL ECONOMICS**

7. ELCT 342 Agribusiness Management 3(2+1)

### **PLANT PHYSIOLOGY**

8. ELCT 362 Micro-propagation Technologies 3(1+2)

### **PLANT PATHOLOGY**

9. ELCT 272 Food Safety Issues 3(2+1)

### **HORTICULTURE**

10. ELCT 283 Hi-tech. Horticulture 3(2+1)

11. ELCT 382 Landscaping 3(2+1)

12. ELCT 383 Protected Cultivation 3(2+1)

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**Total**

**36(21+15)**

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\*Remedial\*\*Non gradial

## SEMESTER WISE DISTRIBUTION OF COURSES

### I SEMESTER

	<b>Course title</b>	<b>Credits</b>
AGRO 101	Agriculture Heritage*	1(1+0)*
AGRO 102	Fundamentals of Agronomy	3(2+1)
BICM 101	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
ENGL 101	Comprehension and Communication Skills in English	2 (1+1)
CPHY 161/ SMCA 101	Introductory Biology* / Elementary Mathematics*	2(1+1)*
SSAC 121	Fundamentals of Soil Science	3(2+1)
AECO 141	Fundamentals of Economics	3(3+0)
HORT 181	Fundamentals of Horticulture	2 (1+1)
AEXT 190	Human Values and Ethics (non gradial)	1(1+0)**
AEXT 191	Rural Sociology and Educational Psychology	2 (1+1)
COCA 100	NSS/NCC/Physical Education and Yoga Practices**	2 (0+2)**
		<b>24 (15+9)</b>

### II SEMESTER

	<b>Course title</b>	<b>Credits</b>
AMBE 101	Agricultural Microbiology	2(1+1)
AGRO 103	Introductory Agrometeorology and Climate Change	2 (1+1)
AGRO 104	Introduction to Forestry	2 (1+1)
GPBR 111	Fundamentals of Genetics	3(2+1)
ENTO 131	Fundamentals of Entomology I (Insect Morphology and Taxonomy)	3(2+1)
AENG 151	Soil and Water Conservation Engineering	2(1+1)
CPHY 162	Fundamentals of Crop Physiology	3(2+1)
PATH 171	Fundamentals of Plant Pathology I (Plant Pathogens - An Introduction)	3(2+1)
HORT 182	Production Technology of Fruits and Plantation Crops	2 (1+1)
		<b>22 (13+9)</b>

### III SEMESTER

	<b>Course title</b>	<b>Credits</b>
AGRO 201	Crop Production Technology - I ( <i>Cereals, Millets and Pulses</i> )	3 (2+1)
GPBR 211	Fundamentals of Plant Breeding	3 (2+1)
ENTO 231	Fundamentals of Entomology II (Insect Ecology and Concepts of IPM)	2(1+1)
AECO 241	Agricultural Finance and Co-operation	2 (1+1)
AENG 251	Farm Machinery and Power	2 (1+1)
CPHY 261	Eco-physiology	2(1+1)
PATH 271	Fundamentals of Plant Pathology II (Plant Pathology Principles)	2(1+1)
HORT 281	Production Technology for Vegetables and Spices	2 (1+1)
AEXT 291	Fundamentals of Agricultural Extension	3(2+1)
COCA 200	Education Tour**	2(0+2)
		<b>23 (12+11)</b>

### IV SEMESTER

	<b>Course title</b>	<b>Credits</b>
AGRO 202	Crop Production Technology - II ( <i>Oilseeds, Fibre, Sugar, Tobacco and Fodder crops</i> )	3 (2+1)
AGRO 203	Farming Systems and Sustainable Agriculture	1 (1+0)
AGRO 204	Irrigation Water Management	2 (1+1)
SMCA 201	Statistical Methods	2(1+1)
LSPM 201	Live-stock and Poultry Management	3 (2+1)
SSAC 221	Manures, Fertilizers and Soil Fertility Management	3(2+1)
AECO 242	Agricultural Marketing, Trade and Prices	3 (2+1)
AENG 252	Renewable Energy and Green Technology	2 (1+1)
HORT 282	Production Technology for Ornamental Crops, Medicinal and Aromatic Plants and Landscaping	2 (1+1)
AEXT 292	Entrepreneurship Development and Business Communication	2(1+1)
ELCT 222/272/283	Elective Course	3 credit
		<b>23 (14+09)+ 3credit***</b>

## V SEMESTER

Course title	Credits
AGRO 301 Geoinformatics and Nanotechnology for Precision Farming	2 (1+1)
AGRO 302 Practical Crop Production	1 (0+1)
BICM 300 Principles of Food Science and Nutrition	2(2+0)
GPBR 311 Crop Improvement - I ( <i>Cereals, Millets, Pulses and Oilseeds</i> )	2 (1+1)
GPBR 313 Intellectual Property Rights	1(1+0)
SSAC 321 Problematic Soils and their Management	2(1+1)
ENTO 331 Pests of Field crops and Stored Grain and their Management	3 (2+1)
AENG 351 Protected Cultivation and Post-harvest technologies	2 (1+1)
CPHY 361 Environmental Studies and Disaster Management	2(1+1)
PATH 371 Diseases of Field and Horticultural Crops and their Management - I (Field Crops)	3 (2+1)
PATH 373 Principles of Integrated Pest and Disease Management	2(1+1)
ELCT 305/333/ 342/362/382 Elective Course	3 credit
	<b>22 (13+9)+ 3 credit***</b>

## VI SEMESTER

Course title	Credits
AGRO 303 Rainfed Agriculture and Watershed Management	2(1+1)
AGRO 304 Principles of Organic Farming	2(1+1)
SMCA 301 Agriculture Informatics	2(1+1)
GPBR 312 Crop Improvement-II ( <i>Fibre, Sugar, Starches, Narcotics, Vegetables, Fruits and Flowers</i> )	2 (1+1)
GPBR 314 Principles of Seed Technology	3 (2+1)
ENTO 332 Pest of Horticultural Crops and their Management and Beneficial insects	3(2+1)
AECO 341 Farm Management, Production and Resource Economics	2 (1+1)
PATH 372 Diseases of Field and Horticultural Crops and their Management - II (Horticultural Crops)	2 (1+1)
HORT 381 Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
AEXT 391 Communication Skills and Personality Development	2(1+1)
ELCT 306/ 315/334/383 Elective Course	3 credits
	<b>22 (12+10)+ 3credit***</b>

\*Remedial \*\*Non gradial \*\*\* Elective Courses

## VII SEMESTER

	<b>Course title</b>	<b>Credits</b>
RAWE	Rural Agricultural Work Experience (RAWE) and Agro Industrial Attachment (AIA)	
	Crop Production	5 (0+5)
	Crop Protection	4 (0+4)
	Rural Economics	3 (0+3)
	Extension Programme	4 (0+4)
	Research Station / KVK /DAATT Centre activities and attachment to Agro based industries	4 (0+4)
		<b>20(0+20)</b>

## VIII SEMESTER

	<b>Course title</b>	<b>Credits</b>
AELP	Experiential Learning Programme (ELP)	20 (0+20)
		<b>20 (0+20)</b>

## Elective Courses

<b>Course No.</b>	<b>Courses</b>	<b>Credit Hours</b>
ELCT 222	Soil, Plant, Water and Seed Testing	3(1+2)
ELCT 272	Food Safety Issues	3(2+1)
ELCT 283	Hi-tech. Horticulture	3(2+1)
ELCT 305	Agricultural Waste Management	3(2+1)
ELCT 306	Weed Management	3(2+1)
ELCT 315	Commercial Plant Breeding	3(1+2)
ELCT 333	Biopesticides and Biofertilizers	3(2+1)
ELCT 334	Agrochemicals	3(2+1)
ELCT 342	Agribusiness Management	3(2+1)
ELCT 362	Micro propagation Technologies	3(1+2)
ELCT 382	Landscaping	3(2+1)
ELCT 383	Protected Cultivation	3(2+1)

**Course outlines****Theory**

Introduction of Indian agricultural heritage, status of farmers in society, advice by sages to kings on their duties towards farmers, soil management in ancient, medieval & pre-modern India and its relevance in modern day sustainable agriculture, heritage of crop & water management, plant growth and development & plant protection through vrikshayurveda and traditional knowledge. Heritage of medicinal plants and their relevance today, seed health in ancient & medieval history and its relevance to present day agriculture, description of Indian civilization and agriculture by travelers from China, Europe and United States, our journey in agriculture, green revolution and its impact and concerns, vision for the future.

**Lectures outlines****Theory**

1. Introduction to Indian agricultural heritage – Definition of heritage, agriculture heritage - Need to study agriculture heritage
2. Genesis of agriculture and its chronological arrangement - Homes of evolution of agriculture and “old and new” world - Early indigenous domestications.
3. Status of farmers in society and specific role of women in ensuring food security- Farming systems in ancient periods.
4. Status of agriculture and advice by sages to kings on their duties towards farmers- Importance of farmers - Ancient agricultural practices and scientific basis.
5. Soil management in ancient, medieval, pre- modern India - Historical background - Soil management and its relevance in pre-modern India and modern day sustainable agriculture - Use of amendments - Land management, Piercing, tillage, puddling and pre-plant submergence, mulching, fallowing.
6. Soil concept - Ancient systems of soil classification - Ancient systems of soil management - Medieval and pre modern soil management.
7. Heritage of crop and water management – Ancient and pre-historic period; Medieval period.
8. Plant growth and development- Heritage of plant protection through vrikshayurveda and traditional Knowledge
9. Plant protection in ancient India - Plant disorders – Cause, symptoms, treatment materials.
10. Traditional knowledge in crop production and water management
11. Heritage of medicinal plants and their relevance today

12. Seed health in ancient and medieval history and its relevance to present day agriculture-seed health in Hellenistic age – seed health in India - Materials recommended for seed treatments.
13. Description of Indian civilization and agriculture by travellers from China, Europe and USA.
14. Pre-historic cropping patterns.
15. Our journey in agriculture-Green revolution and its impact and concerns.
16. Vision for the future – Challenges ahead.

### References

1. Choudary S.L, Sharma, G.S, and Nene, Y.L (eds). 2000. Ancient and Medieval History of Indian agriculture and its relevance to sustainable agriculture in the 21<sup>st</sup> century; Proceedings of the summer school held from 28 May to 17 June 1999. Rajasthan college of Agriculture, Udaipur 313001.
2. Nene, Y.L (Ed). 2005. Agricultural Heritage of Asia proceedings of the international conference, 6-8 December 2004, Asian-Agri history Foundation, Secunderabad- 500 009, Andhra Pradesh, India.
3. Nene, Y.L 2007. Glimpses of Agricultural heritage of India. Asian- Agri- History Foundation, 47 – ICRISAT Colony-1 Brig sayeed Road, Secunderabad -500009 A.P India 901PP ISBN-81-903963-0-7.

**AGRO 102**

**FUNDAMENTALS OF AGRONOMY**

**3(2+1)**

### Course outlines

#### Theory

Agronomy and its scope; Seeds and sowing, tillage and tilth, crop density and geometry; Crop nutrition, manures and fertilizers, nutrient use efficiency; Water resources, soil plant water relationship, crop water requirement, water use efficiency; Irrigation, scheduling criteria, methods, quality of irrigation water and water logging.

Weeds, importance, classification, crop weed competition, concepts of weed management, principles and methods; Herbicides, classification, selectivity, resistance , allelopathy; Growth and development of crops, factors affecting growth and development, plant ideotypes; Crop rotation and its principles; Adaptation and distribution of crops, crop management technologies in problematic areas; Harvesting and threshing of crops.

#### Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements; Effect of sowing depth on germination and seedling vigour; Identification of weeds in crops, methods of herbicide and fertilizer application; Study of yield contributing characters, yield estimation, seed germination and viability test; Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement: Use of tillage implements, reversible plough, one way plough, harrow, leveler and seed drill; Study of

soil moisture measuring devices, measurement of field capacity, bulk density and infiltration rate and measurement of irrigation water.

## **Lecture outlines**

### **Theory**

- 1 Agriculture - Agronomy and its scope- Role of Agronomists in resource management for crop production
- 2 Tillage and tilth - Objectives of tillage- Characteristics of ideal seed bed- Effect of tillage on soil properties
- 3 Types of tillage- Factors affecting tillage and seed bed preparation - After cultivation- Puddling.
- 4 Concepts of tillage – Minimum tillage, zero tillage, strip tillage, conservation tillage and their advantages and limitations.
- 5 Seeds and sowing- Characteristics of good quality of seed, seed treatment, agronomic significance of seed purity and quality - Methods of sowing, importance of time and depth of sowing.
- 6 Crop density and geometry - Crop stand establishment, factors affecting optimum stand establishment.
- 7 Plant population – Competition, types of competition, intra and inter plant competition - Effect of plant population on growth and yield, optimum plant density and planting pattern.
- 8 Soil fertility and soil productivity – Soil organic matter and its importance - Loss of soil fertility and its maintenance.
- 9 Crop nutrition – Essential plant nutrients- Primary, secondary and micro nutrients – Nutrient uptake – Nutrient use efficiency
- 10 Manures and fertilizers- Types of manures and fertilizers - Factors influencing methods and time of fertilizer application - Bio-fertilizers..
- 11 Irrigation - Importance of Irrigation - Objectives of irrigation - Methods of irrigation and water use efficiency
- 12 Crop growth and development - Factors affecting growth and development - Agronomic manipulation of crop growth and development.
- 13 Plant ideotypes – Concept, definition- Morphological and physiological characteristics of new plant types.
- 14 Cropping pattern, Cropping system (navadhanya concept) - Crop rotation – Principles of crop rotation - Mono cropping and its disadvantages – Types of cropping systems- Mixed, multiple, intercropping, relay and multistoried cropping
- 15 Crop adaptation and distribution in India and Andhra Pradesh - Factors influencing crop adaptation and distribution.
- 16 Common problems in crop production related to climate, soil, pest and disease incidence - Crop management technologies to overcome the problems identified.

- 17 Dryfarming, dryland farming and rainfed farming – Classification of climate – Problems of crop production in dry areas.
- 18 Soil moisture conservation and water harvesting measures – Watershed: Objectives and components – Watershed management
- 19 Weed –Definition – Importance- Harmful and beneficial effects of weeds – Aquatic weeds
- 20 Classification of weeds - Based on morphology, life cycle, habitat, origin, association and special features with examples
- 21 Propagation of weeds – Sexual – Asexual- Vegetative (Rhizomes, root stocks, runners, stolons, suckers, offsets, tubers, bulbs, bulbils, stems and roots)
- 22 Weed biology- Characteristic features of weeds, weed ecology – Persistence of weeds, climatic, edaphic and biotic factors.
- 23 Crop weed association – Factors affecting crop weed competition- Common weeds associated with major crops like rice, maize, wheat, sorghum, pulses, groundnut, sugarcane, cotton, and tobacco
- 24 Crop-weed-competition - Critical period of crop weed competition – Allelopathy.
- 25 Methods of weed management - Prevention, control and eradication – Physical, mechanical and cultural methods - Chemical and biological methods of weed control – Integrated weed management
- 26 Herbicides- Definition, advantages and limitations of herbicide usage in India.- Bioherbicides
- 27 Classification of herbicides based on chemical nature, time and method of application
- 28 Herbicidal formulations – active ingredient- Acid equivalent- Nomenclature of herbicides.
- 29 Adjuvants and their use in herbicide application –Types of adjuvants with examples.
- 30 Mode of action of herbicides - Important biochemical modes of action of herbicides (especially interfering with photosynthesis and respiration).
- 31 Selectivity and resistance- Selectivity of herbicides - Fundamental principles of selectivity- Differences in morphology and growth habit of plants - Differential absorption and translocation of herbicides.
- 32 Harvesting and threshing of crops - Maturity symptoms of major crops - Time and methods of harvesting - Threshing and winnowing, drying and post harvesting storage of grains -Harvest index and BC ratio.

### **Practical**

1. Visit to college farm and identification of major crops and varieties
2. Practice of primary tillage implements and puddling
3. Practice of secondary tillage implements

4. Practice of seeding equipment , inter cultivation implements
5. Seed germination and viability test - Study of sowing depth on germination and seedling vigour
6. Identification of manures, fertilizers and green manure crops/seeds.
7. Practice of manure and fertilizer application
8. Participation in ongoing field operations
9. Participation in ongoing field operations
10. Identification of weeds in field crops and other habitats
11. Study of weed flora in different weed management practices and calculation of herbicide efficiencies (WI & WCE)
12. Herbicide label information and computation of herbicide doses
13. Study of herbicide application equipment and calibration
14. Herbicide application and precautionary measures
15. Study of herbicide phytotoxicity symptoms in different crops
16. Identification of maturity symptoms of different crops

### References

1. Reddy, S.R. 2016. Principles of Agronomy. Kalyani Publishers,Ludhiana - 5<sup>th</sup> edition
2. Yellamanda Reddy, T. and Sankara Reddi, G. H. (2016) Principles of Agronomy. Kalyani Publishers,Ludhiana.
3. Gopal Chandra de.1989.Fundamentals of Agronomy. Oxford & IBH Publishing Co. Pvt. Ltd. , New Delhi.
4. Gupta,O.P. 2011. Modern weed management. Agrobios (India), Jodhpur.

**AGRO 103**

### **INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE**

**2(1+1)**

### Course outlines

#### Theory

Earth atmosphere, composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, long wave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking; Monsoon,

mechanism and importance in Indian agriculture; Weather hazards, drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave; Agriculture and weather relations, modifications of crop microclimate, climatic normals for crop and livestock production; Weather forecasting, types of weather forecast and their uses; Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

### **Practical**

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

### **Lecture outlines**

#### **Theory**

1. Introduction: The three spheres of the earth; Terminology and definitions: Meteorology, Climatology, Agrometeorology, Agroclimatology climate and weather - Scope and importance of agrometeorology.
2. Agro climatic regions of India and Agroclimatic zones of Andhra Pradesh.
3. Atmosphere -Composition of the atmosphere-Weather elements- Extent and structure of the atmosphere.
4. Solar Radiation: Nature and properties of solar radiation - Conduction – Convection - Radiation - Solar Spectrum - Distribution of solar radiation within the crop canopies- Physiological response of different bands of incident radiation - Definitions of solar constant, net radiation, albedo - Solar radiation and crops
5. Temperature: Temperature and heat, definitions- Temperature inversion- Adiabatic lapse rate - Daily and seasonal variations of temperature – Vertical profile of temperature- Energy balance of earth
6. Low air temperature and plant injury and high air temperature and plant injury- Soil temperature- Factors affecting soil temperature- Temperature and crops.
7. Humidity: Concept of saturation- Vapour pressure- Types of humidity- Humidity and crops- Atmospheric Pressure: Definitions of pressure, atmospheric pressure, standard atmospheric pressure
8. 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

9. Precipitation: Process of precipitation, types of rainfall (orographic, convectional and cyclonic)- Definition of cloud – WMO classification of clouds.
10. Forms of precipitation (solid, liquid and mixed) and condensation (dew, fog, mist, frost, cloud) - Artificial rain making- Monsoon: Indian monsoons, SW monsoon & NE monsoon.
11. Importance of monsoon in Indian agriculture- date of onset, significant features of Indian monsoon; length of growing season.
12. Weather hazards: Drought-Floods-Cyclones-Heat and cold-waves and their management.
13. Weather Forecasting: Importance-Types of weather forecast and their uses-Synoptic charts - Remote sensing-Applications of remote sensing in agriculture - Agrometeorological Advisory services in India.
14. Climate change- variability-Global processes and effects- Green house effect-Temperature changes on the earth- Precipitation changes on the earth- Changes in extreme events- Sea level raising- Tracking climate change- Impacts of climate change on agriculture- Climate neutral
15. Summary of evidence for climate change- Basic models for evaluating climate change Impacts -Specific weather related effects due to climate change.
16. Micro climate- micro climate scales – Modifications of crop microclimate - Examples of manipulation of climate- Climatic normals for crop and livestock production

### **Practical**

1. Visit to Agrometeorological Observatory, site selection and layout plan for observatory.
2. Exposure to agrometeorological instruments and weather data recording.
3. Measurement of total, shortwave and longwave radiation and its estimation by using Planck's intensity law.
4. Measurement of albedo and sunshine duration.
5. Computation of radiation Intensity using bright sun shine hours.
6. Measurement of maximum and minimum air temperatures and interpretation of decennial temperature data.
7. Tabulation of maximum and minimum air temperatures, trend and variation analysis for climate change of the region.
8. Measurement of soil temperature and computation of soil heat flux.
9. Determination of atmospheric pressure and vapour pressure.
10. Determination of relative humidity.
11. Determination of dew point temperature- Measurement of atmospheric pressure and analysis of atmospheric conditions.

12. Measurement of wind speed and wind direction, preparation of windroses-Measurement, tabulation and analysis of rainfall data.
13. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET-Preparation of synoptic chart and report
14. Computation of climate change and variability
15. Crop planning for climate change
16. GDD, HTU and PTU calculations and their interpretation using their efficiencies

### References

1. Radha Krishna Murthy,V.2016. Principles and practices of agricultural disaster management. B.S Publications, Koti, Hyderabad.
2. Reddy, S.R.2014. Introduction to Agriculture and Agrometeorology. Kalyani Publishers, Ludhiana, Punjab.
3. Radha Krishna Murthy, V. 2002. Basic Principles of Agricultural meteorology. B.S Publications, Koti, Hyderabad.

**AGRO 104**

**INTRODUCTION TO FORESTRY**

**2(1+1)**

### Course outlines

#### Theory

Introduction, definitions of basic terms related to forestry; Objectives of silviculture, forest classification, salient features of Indian forest policies; Forest regeneration, natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration, objectives, choice between natural and artificial regeneration, essential preliminary considerations. Crown classification. Tending operations, weeding, cleaning, thinning, mechanical, ordinary, crown and advance thinning; Forest mensuration, objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement, shadow and single pole method, instrumental methods of height measurement, geometric and trigonometric principles, instruments used in height measurement, tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees; Agroforestry, definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens; Cultivation practices of two important fast growing tree species of the region.

#### Practical

Identification of tree-species, diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees; Height measurement of standing trees by shadow method, single pole method and hypsometer; Volume measurement of logs using various formulae; Nursery lay out, seed sowing, vegetative propagation techniques; Forest plantations and their management, visits to nearby forest based industries.

## Lecture outlines

### Theory

1. Introduction – definitions of basic terms related to forestry, Indian forest, target area, productivity
2. Influence of forest on climate, soil, floods, erosion, human health and recreation.
3. Objectives of silviculture, forest classification, salient features of Indian forest policies.
4. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers.
5. Artificial regeneration – objectives, choice between natural and artificial regeneration, planting methods, essential preliminary considerations. Crown classification.
6. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning.
7. Principles and practices of social forestry nurseries- types of nurseries - success in nursery production.
8. Afforestation in different sites - shifting sand dunes, saline soils, ravine lands, wet lands, lateritic soils, dry rocky soils, canal banks, road sides and watershed areas.
9. Village wood lots, selection of species - measures for shortage of fuel wood- Properties of fuel wood- management and advantages of energy plantations- Suitable tree species
10. Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement - shadow and single pole method;
11. Instrumental methods of height measurement - geometric and trigonometric principles, instruments used in height measurement;
12. Tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees.
13. Major and minor forest products
14. Agroforestry – definitions, importance, criteria of selection of trees in agroforestry
15. Different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens.
16. Cultivation practices of Subabul, Eucalyptus and Casuarina tree species.

### Practical

1. Identification of tree-species.
2. Diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees.
3. Height measurement of standing trees by shadow method, single pole method and hypsometer.

4. Volume measurement of logs using various formulae.
5. Biomass estimation in energy plantations
6. Nursery lay out, seed sowing,
7. Application of pre-sowing seed treatments
8. Vegetative propagation techniques.
9. Field planting techniques
10. Forest plantations and their management.
11. Identification of important major and minor forest products
12. Visits of nearby forest based industries.
13. Visit to social nurseries of forest department
14. Visit to energy plantations and forest research centres.
15. Visits to nearby forest based industries.
16. Collection and maintenance of forest products and herbarium

### References

1. Dwivedi, A.P. 1980. Forestry in India, Jugal Kishore and Company, DehraDun
2. Negi, S.S. 1999. Agroforestry hand book, International book distributor, DehraDun.
3. Ram Prakash and Drake Hocking. 1986. Some favourite trees for fuel and fodder, International book distributor, Dehradun.
4. Singh, S.P. 2009. Tree farming-. Agrotech Publishing academy, Udaipur.
5. Singh, S.P. 2010. Favourite Agroforestry trees, Agrotech Publishing academy, Udaipur.
6. Troup, T.S. 1986. Silviculture of Indian trees (Vol. II & III)- International book distributor, Dehradun.

**AGRO 201**

**CROP PRODUCTION TECHNOLOGY - I  
(CEREALS, MILLETS AND PULSES)**

**3(2+1)**

### Course outlines

#### Theory

Origin, geographical distribution, economic importance, area, production and productivity; Soil and climatic requirements, climate resilience; Varieties, cultural practices and yield of cereal, millet and pulse crops; Cereals, rice, wheat, barley, maize, sorghum, pearl millet, finger millet, proso millet, little millet, kodo millet, foxtail millet and barnyard millet; Pulses, pigeonpea, greengram, blackgram, bengalgram, lentil, peas, horsegram and cowpea.

#### Practical

Rice nursery preparation, transplanting of rice, sowing of pigeonpea, greengram and maize, effect of seed size on germination and seedling vigour of cereal and pulse

crops, effect of sowing depth on germination of cereal and pulse crops, identification of weeds in cereal and pulse crops, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of cereal and pulse crops, study of crop varieties and important agronomic experiments at experimental farm, morphological description of cereal and pulse crops, visit to research centers of related crops.

## Lecture outlines

### Theory

1. Cereals – Importance and special features of cereals - **Rice**- Origin - geographical distribution – nutritional value – area, production and productivity in India and Andhra Pradesh
2. Economic importance - soil and climatic requirements
3. Classification of rice plant types - growth Stages of rice -different types of rice ecosystems
4. Land Preparation –physico – chemical and biological changes under submerged soils
5. Crop establishment techniques in rice - Climate resilient technologies
6. Nutrient management with special emphasis on nitrogen dynamics, micro nutrients -INM
7. Water management in rice under different rice ecosystems
8. Weed management including weed management in rice nurseries – IWM
9. Harvesting -Yield attributes - yield - post harvest operations - milling of rice
10. Value added products of rice – export potential - rice grain classification, cropping systems in rice
11. **Wheat**- Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance - soil and climatic requirements - zones of wheat cultivation - growth Stages - Classification
12. Land Preparation - seeds and sowing - nutrient management - water management - weed management - climate resilient technologies
13. Harvesting -yield attributes – yield - post harvest operations – wheat based cropping systems – value addition
14. **Barley** – Origin- geographical distribution - economic importance- classification - area, production and productivity in India and Andhra Pradesh - soil and climatic requirements --varieties - cultural practices - Harvesting -Yield attributes – yield
15. **Maize**- Origin- geographical distribution - economic importance - area, production and productivity in India and Andhra Pradesh- soil and climatic requirements - growth stages - Classification of maize
16. Land Preparation – zero tillage - seeds and sowing - nutrient management - water management - weed management - climate resilient technologies

17. Harvesting - yield attributes – yield - post harvest operations - value addition - cropping systems
18. **Millets**- Economic importance - constraints and strategies for increasing the production of millets - climate resilient technologies
19. **Jowar**- Origin - geographical distribution - economic importance - area, production and productivity in India and Andhra Pradesh - soil and climatic requirements - zones of jowar cultivation - growth Stages - Land Preparation - seeds and sowing
20. Nutrient management - water management - weed management – harvesting- yield attributes – yield - post harvest operations - value addition- sorghum effect, mid season corrections - cropping systems
21. **Pearl millet** – Origin - geographical distribution - economic importance - area, production and productivity in India and Andhra Pradesh- soil and climatic requirements -growth Stages - land preparation - seeds and sowing - Nutrient management - sater management - weed management – harvesting- yield attributes – yield - post harvest operations - value addition - cropping systems
22. **Finger millet**- Origin - geographical distribution - economic importance - area, production and productivity in India and Andhra Pradesh- soil and climatic requirements, growth Stages - land preparation, seeds and sowing - nutrient management - water management - weed management – harvesting - yield attributes – yield - post harvest operations - value addition - cropping systems
23. **Proso millet, Little millet and Kodo millet** – Origin - geographical distribution - economic importance - adaptations, soil and climatic requirements - growth Stages - land preparation - seeds and sowing - nutrient management - water management - eed management – harvesting - yield attributes – yield - post harvest operations
24. **Foxtail millet, Barnyard millet**- Origin - geographical distribution- economic importance – Adaptations - soil and climatic requirements - growth Stages- land preparation- seeds and sowing- nutrient management - water management - weed management- harvesting - yield attributes – yield - post harvest operations
25. **Pulses**- Economic importance - constraints for achieving higher productivity of pulses, strategies for improving the pulse production in India - climate resilient technologies
26. **Pigeonpea**- Origin - geographical distribution - economic importance- area, production and productivity in India and Andhra Pradesh - soil and climatic requirements - growth Stages - land Preparation - seeds and sowing – varieties - nutrient management - water management - weed management – harvesting- yield attributes – yield - post harvest operations - cropping systems
27. **Greengram** – Origin - geographical distribution - economic importance - area, production and productivity in India and Andhra Pradesh - soil and climatic requirements growth stages - land Preparation- seeds and sowing – varieties- nutrient management -water management- weed management- harvesting- yield attributes – yield - post harvest operations - cropping systems

28. **Blackgram** – Origin- geographical distribution,- economic importance - area, production and productivity in India and Andhra Pradesh - soil and climatic requirements - growth stages - land Preparation - seeds and sowing – varieties- nutrient management - water management- weed management - harvesting- yield attributes – yield - post harvest operations - cropping systems
29. **Bengalgram** - Origin - geographical distribution- economic importance- area, production and productivity in India and Andhra Pradesh - soil and climatic requirements- growth stages -types of chick pea -land preparation - seeds and sowing- varieties- nutrient management- water management- weed management- harvesting- yield attributes – yield - post harvest operations - cropping systems
30. **Lentil, peas**- Origin- geographical distribution - economic importance- area, production and productivity in India and Andhra Pradesh - soil and climatic requirements- growth stages-types of lentil and peas - land Preparation - seeds and sowing – varieties- nutrient management- water management- weed management- harvesting- yield attributes – yield - post harvest operations - cropping systems
31. **Horsegram**- Origin- geographical distribution - economic importance - area, production and productivity in India and Andhra Pradesh - soil and climatic requirements- growth stages - land Preparation- seeds and sowing – varieties- nutrient management- water management- weed management- harvesting- yield attributes – yield - post harvest operations - cropping systems
32. **Cowpea**- Origin -geographical distribution- economic importance - area, production and productivity in India and Andhra Pradesh - soil and climatic requirements - growth Stages - land preparation- seeds and sowing- varieties - nutrient management- water management- weed management- harvesting- yield attributes – yield - post harvest operations - cropping systems

### Practical

1. Raising of rice nurseries including SRI nursery for mechanical transplanting
2. Transplanting of rice
3. Identification of seeds /crops and calculation of seed rate
4. Land preparation and layout of student plots
5. Sowing of crops in student plots
6. Study of the effect of seed size on germination and seedling vigor
7. Identification and management of weeds in cereals and pulses
8. Fertilizer application(top dressing and foliar feeding of nutrients)
9. Agronomic characters of cereal crop varieties
10. Agronomic characters of millet crop varieties
11. Agronomic characters of pulse crop varieties
12. Biometric observations in student plots
13. Study of growth stages/ morphological description of different crops

14. Study of yield attributes, Harvesting and recording of yield
15. Visit to research centers to study the related crops
16. Visit to post harvest processing units

### References

1. Rajendra Prasad. 2006. Text book of field crops production. ICAR, New Delhi.
2. Reddy, S.R. and Reddi Ramu. 5<sup>th</sup> edition. 2016. Agronomy of field crops. Kalyani publishers, Ludhiana.
3. Gururaj hunsigi and Krishna, K.R. 2007. Scientific field crop production. Oxford & IBH Publishing Co.Pvt.LTD.
4. De Datta, S.K.1981. Principles and practices of rice Production. John Wiley and Sons, New York

## AGRO 202 CROP PRODUCTION TECHNOLOGY-II 3(2+1) (OIL SEEDS, FIBER, SUGAR, TOBACCO AND FODDER CROPS)

### Course outlines

#### Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of oil seeds, fiber, sugar, tobacco and fodder crops; Oilseeds, groundnut, sesamum, soybean, rapeseed, mustard, sunflower, safflower, castor, linseed and niger; Fibre crops, cotton, jute, mesta; Sugar crops, sugarcane, sugarbeet; Other crops, potato, tobacco; Forage crops, sorghum, cowpea, cluster bean, napier, maize, lucerne, berseem and oat.

#### Practical

Sowing methods of sugarcane, sowing of soybean, cotton, groundnut, jute, mesta; Identification of weeds in oil seeds, fiber crops; Study of morphological characteristics of oil seeds, fiber crops; Study of yield contributing characters of oil seeds, fiber crops; Yield and juice quality analysis of sugarcane; Study of important agronomic experiments of oil seeds, fiber crops at experimental farms, study of forage experiments, hay and silage; Oil extraction of medicinal crops, visit to research stations of related crops.

### Lecture outlines

#### Theory

1. Importance of oilseed crops- edible and non – edible oils – nutritional value- importance in Indian economy- constraints in oilseed production.
2. Need for improvement of productivity and production of oilseeds -climate resilient technologies- **Groundnut** – Origin - geographical distribution -area, production and productivity in India and Andhra Pradesh- economic importance
3. Soil and climatic requirements - types - growth stages - land Preparation -seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing - varieties- nutrient management

4. Water management -weed management- yield attributes –yield- harvesting, post harvest operations- quality considerations -cropping systems – value addition in groundnut.
5. **Soybean**-Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements-Land preparation - seeds and sowing-seed viability - seed treatment-seed rate-spacing-season-time and method of sowing- varieties -nutrient management- water management- weed management yield attributes –yield- harvesting – shattering- post harvest operations- quality considerations- cropping systems
6. **Sunflower** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements-Land preparation - seeds and sowing-seed treatment-seed rate-spacing-season-time and method of sowing- varieties -nutrient management-water management-weed management - yield attributes –yield- harvesting– post harvest operations- quality considerations – seed production-seed setting problems and measures-cropping systems.
7. **Sesame** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements-Land preparation - seeds and sowing- seed treatment-seedrate-spacing-season-time and method of sowing- varieties - nutrient management- water management- weed management yield attributes –yield- Harvesting – post harvest operations- Quality considerations – cropping systems.
8. **Rapeseed and mustard** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements-Land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing- varieties.
9. Nutrient management- water management- weed management yield attributes – yield- Harvesting – post harvest operations- quality considerations – cropping systems.
10. **Safflower** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements-Land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing- varieties - nutrient management- water management-weed management - yield attributes –yield- harvesting – post harvest operations-quality considerations – cropping systems.
11. **Castor** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements-Land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing- varieties –nipping- nutrient management- water management- weed management - yield attributes –yield- harvesting – post harvest operations- quality considerations – cropping systems.

12. **Linseed**– Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements- Land preparation - seeds and sowing- seed treatment-seed rate-spacing-season- pyra /utera, time and method of sowing- varieties – nutrient management- water management- weed management - yield attributes –yield- harvesting – post harvest operations- quality considerations – cropping systems.
13. **Niger** - Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- soil and climatic requirements- Land preparation - seeds and sowing- seed treatment-seed rate-spacing-season- time and method of sowing- varieties - nutrient management- water management- weed management - yield attributes –yield- harvesting – post harvest operations- quality considerations – cropping systems.

### **Fibre crops: Cotton, Jute and Mesta**

14. **Cotton**- Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- classification- soil - climatic requirements- land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing.
15. Varieties/Bt cotton - growth stages – branching- nutrient management - water management- weed Management- topping- bud and boll shedding
16. Yield attributes –yield- harvesting-defoliants-mechanized harvesting - quality considerations -cropping systems- climate resilient technologies
17. **Jute**- Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- - soil - climatic requirements- types of jute- - land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing- varieties - nutrient management - water management- weed management-yield attributes - yield- harvesting – processing of jute- quality considerations- cropping systems.
18. **Mesta** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance- - soil - climatic requirements- types of mesta - land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and method of sowing- varieties - nutrient management - water management- weed management-yield attributes –yield- harvesting –processing of mesta- quality considerations- cropping systems.

### **Sugar crops- Sugarcane and Sugarbeet**

19. **Sugarcane** – Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance - soil - climatic requirements– Influence of rainfall, temperature, light- land preparation –planting time in Coastal and Rayalseema regions of AP
20. Planting material – setts – short crop – nursery crop – different methods of planting – growth stages

21. Nutrient Management – crop logging- trash mulching – wrapping and propping- water management- weed management- criteria for judging maturity- climate resilient technologies
22. Ratoon cane management – factors affecting quality of sugarcane – arrowing- jaggery making – clarification.
23. Sugarbeet – Origin - geographical distribution - area, production and productivity in India - economic importance- soil - climatic requirements - Land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and - nutrient management - water management- weed management- yield attributes –yield- harvesting - quality considerations- cropping systems
24. **Tobacco** –Origin - geographical distribution - area, production and productivity in India and Andhra Pradesh - economic importance - soil - climatic requirements- types of tobacco-Land preparation
25. Nursery management-seeds and sowing for different types- seed treatment-seed rate-spacing-season-time and method of sowing
26. Varieties - nutrient management – topping and desuckering-water management- weed management- yield attributes –yield- harvesting –priming-curing
27. Quality characters-nicotine content, burning quality, aroma and sugar content - methods of curing -flue curing of *Virginia* tobacco - cropping systems
28. **Forage crops**- Importance- terminology in forage production-classification of fodders-sorghum and maize importance-seeds and sowing - nutrient requirement- irrigation- weed management- harvesting –yield- quality of fodder.
29. Cowpea, clusterbean - napier grass - importance- seeds and sowing -nutrient requirement- irrigation- weed management- harvesting –yield- quality of fodder.
30. Lucerne, berseem, oat – importance- seeds and sowing -nutrient requirement- irrigation- weed management- harvesting –yield quality of fodder.
31. **Forage crops**- Quality considerations- preservation of fodder – hay and silage making

#### **Other crops: Potato**

32. **Potato** - Origin - geographical distribution - area, production and productivity in India - economic importance- - soil - climatic requirements – varieties – soil - climatic requirements - land preparation - seeds and sowing- seed treatment-seed rate-spacing-season-time and - nutrient management - water management- weed management- yield attributes –yield- harvesting - quality considerations- cropping systems

#### **Practical**

1. Land preparation and layout of plots
2. Sowing methods of sugarcane
3. Sowing of oil seeds, fiber, sugar crops and fodder crops

4. Identification of plant characteristics of oil seeds, fiber, sugar crops and fodder crops
5. Recording of yield contributing characters(biometric observations) of oil seeds, fiber, sugar crops and fodder crops
6. Yield and juice quality analysis of sugarcane
7. Visit to agronomic experiments of Oil seeds, fiber, sugar crops and fodder crops at experimental farms.
8. Visit to forage experiments
9. Hay and silage making
10. Visit to research stations of related crops
11. Raising of tobacco nursery
12. Visit to related agro-based industries
13. Visit to nearby farmers' fields
14. Visit to nearby processing units
15. Study of quality parameters of mesta and tobacco
16. Collection of post harvest data on the crop

#### **References:**

1. Reddy, S.R. and Reddi Ramu. 5<sup>th</sup> edition, 2016. Agronomy of field crops. Kalyani publishers, Ludhiana.
2. Chidda Singh, Singh, P and Singh, R. 2003. Modern techniques of raising field crops. Oxford & IBH Publishing house, New Delhi.
3. Rajendra Prasad. 2004. Text book of field crops production. Commercial crops, volume-II ,Technical Editor, ICAR, New Delhi.
4. Panda S.C.2014. Agronomy of fodder and forage crops, Kalyani publishers, Ludhiana.

**AGRO 203**

**FARMING SYSTEMS AND  
SUSTAINABLE AGRICULTURE**

**1(1+0)**

#### **Course Outlines**

##### **Theory**

Farming system-scope, importance, and concept; Types and systems of farming system and factors affecting types of farming; Farming system components and their maintenance; Cropping system and pattern, multiple cropping system, efficient cropping system and their evaluation; Allied enterprises and their importance, tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture, problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability; Integrated farming system, historical background, objectives and characteristics, components of IFS and its advantages, site specific development of

IFS model for different agro-climatic zones; Resource use efficiency and optimization techniques, resource cycling and flow of energy in different farming system, farming system and environment; Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

## **Lecture outlines**

### **Theory**

1. Farming System – introduction – scope of farming system – importance – concept – principles of farming system.
2. Types of farming systems – advantages and limitations - suitability – factors affecting the farming system
3. Farming systems – system and systems approach - determinants of farming system – cropping systems(navadhanya concept) and related terminology
4. Allied enterprises – significance of integrating crop and livestock enterprises – components and maintenance- dairying and sheep and goat rearing – breeds – housing– feed and fodder requirements – biogas plant
5. Allied enterprises – poultry farming – breeds – housing –feed and fodder requirements – apiculture – species and management
6. Allied enterprises – sericulture – moriculture and silkworm rearing – agro-forestry systems suitable for dryland farming
7. Tools for determining production and efficiencies in different farming and cropping systems.
8. Adverse effects of modern agriculture - sustainable agriculture –definition –concept – goals – elements.
9. Problems related to soil, water and environment - adaptation and mitigation strategies - indicators of sustainability.
10. Conservation agriculture – concept – need - management of natural resources - land, water and vegetation.
11. Techniques for sustainability - Low External Input Agriculture (LEIA)and Low External Inputs for Sustainable Agriculture (LEISA) and HEIA (High External Input Agriculture).
12. Integrated farming system-historical background, objectives and characteristics-advantages,
13. Site specific development of IFS models for different agro climatic zones of India and A.P.
14. Resource use efficiency – optimization of resource use by different methods in an IFS(Annapurna model)
15. Resource cycling - flow of energy in different farming systems.
16. Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field

## References

1. Arun K. Sharma. 2006. A hand book of organic farming - Agrobios (India) Jodhpur
2. Jayanthi C, Devasenapathy P and Vinnila, C. 2008. Farming systems principles and practice. Satish serial publishing house, Delhi
3. Panda.S.C. 2011. Cropping and farming systems. Agrobios (India) Jodhpur.
4. Ruthenburg, H. 1980. Farming systems in the tropics. Oxford university press.

**AGRO 204**

**IRRIGATION WATER MANAGEMENT**

**2(1+1)**

## Course outlines

### Theory

**Irrigation** : Definition and objectives; Water resources, Irrigation projects (major, medium & minor) in India and Andhra Pradesh; Soil - plant - water relationships; Methods of soil moisture estimation; Evapotranspiration and Crop water requirement; Duty of water; Conjunctive use of water; Scheduling of irrigation; Methods of irrigation - Surface, Subsurface, Sprinkler and Drip irrigation; Irrigation efficiency and Water use efficiency; Irrigation water quality criteria and its management; Waterlogging; Agricultural drainage.

### Practical

Measurement of bulk density, study of soil moisture measuring devices, determination of field capacity and permanent wilting point, measurement of infiltration rate, irrigation water, scheduling of irrigation by IW/CPE ratio method, calculations on soil moisture, irrigation water needs, duty of water and irrigation efficiencies, layout of surface methods of irrigation, demonstration of drip and sprinkler irrigation, visit to micro irrigation systems in farmers fields ,water management practices in different crops.

## Lecture outlines

### Theory

- 1 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.
- 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 – soil moisture characteristic curves- Water movement in soils – infiltration – percolation – seepage – permeability – hydraulic conductivity – saturated and unsaturated water flow.
- 5 Kinds of water in soil – gravitational water – capillary water – hygroscopic water – their importance in crop production - Soil moisture constants – saturation – Field capacity (FC) – Permanent Wilting Point (PWP) – Available Soil Moisture (ASM) – hygroscopic coefficient –theories of soil water availability.

- 6 Plant-water relationships – rooting characteristics – effective root zone depth – moisture extraction pattern – moisture sensitive periods of crops – Soil Plant Atmospheric Continuum (SPAC).
- 7 Evapotranspiration – evaporation – transpiration – factors influencing evapotranspiration – Reference crop evapotranspiration (ET<sub>o</sub>) – Crop coefficient – Crop Evapotranspiration (ET<sub>c</sub>) - 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 – base period – relation between duty and base period – conjunctive use of water – advantages of conjunctive use.
- 9 Scheduling of irrigation – different criteria – soil moisture regime approach – feel and appearance method – soil moisture tension and depletion of available soil moisture method - climatological approach – Irrigation Water (IW) / Cumulative Pan Evaporation (CPE) ratio method.
- 10 Scheduling of irrigation – plant indices approach – visual symptoms – soil cum-sand mini plot technique – growth rate – relative water content – plant water potential – canopy temperature – indicator plants and critical growth stages.
- 11 Methods of irrigation - surface methods – wild flooding check basin, ring basin, border strip, furrow and corrugations – advantages and disadvantages- Sub surface irrigation.
- 12 Micro irrigation systems - sprinkler irrigation – merits and demerits – system components and layout – suitable crops – rain guns.
13. Drip irrigation (surface and sub surface) – merits and demerits – system components and layout – suitable crops - fertigation and maintenance of micro irrigation systems.
14. Water Use Efficiency (WUE) – crop and field water use efficiency – factors influencing WUE – climatic, genetic and management (agronomic) factors - Irrigation efficiencies – water conveyance efficiency, water application efficiency, water storage efficiency, water distribution efficiency and project efficiency.
15. 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.
16. Water logging – causes for waterlogging – drainage- surface and sub-surface drainage systems – relative merits.

### **Practical**

1. Determination of bulk density
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
10. Lay out of surface irrigation methods
11. Problems on duty of water and irrigation efficiencies
12. Demonstration of drip irrigation system (filter cleaning, flushing of laterals and fertigation)
13. Demonstration of operation of sprinkler irrigation system
14. Visit to micro irrigation systems in farmers fields.
15. Water management practices in rice, wheat and maize.
16. Water management practices in groundnut, sunflower and sugarcane.

### References

1. Michael, A.M. 2006. Irrigation – Theory and Practice. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Reddy, S.R. 2016. Irrigation Agronomy 3<sup>rd</sup> Edition. Kalyani Publishers, Ludhiana.
3. Sankara Reddi, G.H. and Yellamanda Reddy, T. 2006. Efficient Use of Irrigation Water. Kalyani Publishers, Ludhiana.
4. Majumdar, D.K. 2013. Irrigation water management: Principles and practices. PHI learning Pvt Ltd, Delhi-92

**AGRO 301**

**GEOINFORMATICS AND NANO TECHNOLOGY  
FOR PRECISION FARMING**

**2(1+1)**

### Course outlines

#### Theory

Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture. Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Geodesy and its basic principles; Remote sensing concepts and application in agriculture; Image processing and interpretation; Global positioning system (GPS), components and its functions; System Simulation- Concepts and principles, Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs; STCR approach for precision agriculture; Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects, nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in tillage, seed, water, fertilizer, plant protection for scaling-up farm productivity.

## Practical

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

## Lecture outlines

### Theory

1. AGRO Precision agriculture: concepts and techniques-Issues and concerns for Indian agriculture
2. AGRO Principles and practices of precision agriculture.
3. AGRO Geo-informatics- definition, concepts, tools and techniques and their use in Precision Agriculture.
4. AGRO Crop discrimination and Yield monitoring techniques
5. AGRO Geodesy and its basic principles
6. AGRO Spatial data and their management in GIS
7. AGRO Global positioning system (GPS) –Components and its application in agriculture
8. AGRO Application of nanotechnology in agriculture - tillage, seed, water, fertilizers, plant protection for scaling-up farm productivity
9. SSAC Cartography, units of cartography, map scale, various symbols used in cartography, Soil mapping techniques
10. SSAC Remote sensing- concepts, Spectral reflectance of various earth features, atmospheric windows
11. SSAC Applications of remote sensing techniques in the field of agriculture and allied sciences including drones.
12. SSAC Spatial variability of soil fertility, its determination, fertilizer recommendation using geospatial technologies in precision farming
13. SSAC Image processing and interpretation - geo referencing - supervised and unsupervised classification of RS images. STCR approach for precision agriculture - principles and computations
14. SSAC Nanotechnology, definition, concepts and techniques – Nano scale – definition – Nano-particles , materials - occurrence – properties
15. SSAC Characterization of nano-materials - structural characterization - Nano-sensors
16. SSAC Nano-fertilizers , nano-pesticides - importance and advantages –synthesis – strategies

## Practicals

1. SSAC GIS software, spatial data creation and editing.
2. SSAC Image processing software.
3. SSAC Visual and digital interpretation of remote sensing images.
4. SSAC Generation of spectral profiles of different objects.
5. AGRO Supervised and unsupervised classification and acreage estimation.
6. SSAC Multispectral remote sensing for soil mapping.
7. SSAC Creation of thematic layers of soil fertility based on GIS.
8. AGRO Creation of productivity and management zones.
9. AGRO Fertilizers recommendations based of VRT and STCR techniques.
10. AGRO Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of drones for assessing crop damage.
11. AGRO Conduct of agricultural survey using GPS.
12. AGRO Use of GPS for watershed management
13. AGRO Use of GPS for crop yield estimation
14. SSAC Formulation, characterization of nanoparticles
15. SSAC Applications of nanoparticles in agriculture.
16. AGRO Projects formulation and execution related to precision farming.

## References

1. Pradeep. T. 2007. NANO: The Essentials:Understanding Nanoscience and Nanotechnology.Tata McGraw-Hill Publishing Company Limited, New Delhi
2. Lillesand, T.M. and Kiefer, R. W. 1994. Remote sensing and image interpretation. (3<sup>rd</sup> edition), John Wiley and Sons.
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**AGRO 302**

**PRACTICAL CROP PRODUCTION**

**1(0+1)**

## Course outlines

### Practical

Crop planning, raising field crops in multiple cropping systems, field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying, winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies, preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

## Lectures outlines

### Practical

1. Crop planning(preparation of cropping scheme).
2. Field preparation- Raising field crops in different cropping systems.
3. Seed treatment, nursery raising, sowing of field crops in different cropping systems.
4. Nutrient management in different field crops.
5. Weed management in different field crops.
6. Management of the pests and diseases.
7. Scheduling of irrigation to different crops.
8. Biometric observations in different crops.
9. Contingent crop planning and mid season correction.
10. Mechanization in different crops.
11. Roughing and other aspects of seed production.
12. Yield attributes and estimation of yield in different field crops.
13. Harvesting and recording of yield.
14. Post harvest operations in different field crops.
15. Assessment of gaps in achieving the targeted yield.
16. Economic analysis and preparation of balance sheet

**AGRO 303**

**RAIN FED AGRICULTURE AND  
WATERSHED MANAGEMENT**

**2(1 + 1)**

### Course outlines

#### Theory

Rainfed agriculture: Introduction, types, History of rainfed agriculture & watershed in India; Problems and prospects of rainfed agriculture in India ; Soil and climatic conditions prevalent in rainfed areas; Drought: types, effect of water deficit on physio- morphological characteristics of the plants, Mechanism of crop adaptation under moisture deficit condition; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices, Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

#### Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different dry land areas in the country and demarcation of dry land area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible

drought period in the country, effective rainfall and its calculation. Studies on cultural practices viz; mulching, plant density, depth of sowing, thinning and leaf removal for mitigating moisture stress. Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

## Lecture outlines

### Theory

1. Rainfed agriculture – introduction and definition – dimensions of the problem – area and production from dry lands in India and Andhra Pradesh –History of rainfed agriculture and watersheds in India.
2. Problems and prospects of rainfed agriculture in India – climate – rainfall pattern – distribution – variabilities of rainfall – short rainy season – high intensity rainfall
3. Problems and prospects of rainfed agriculture in India - soil characteristics – soil fertility status –soil moisture storage and retention capacity – heavy weed infestation-soil crust and their effect on crop growth and soils-its management.
4. Drought – definition – types of drought – effect of water deficits on physio-morphological characteristics of the plants- mechanism of crop adaptation under moisture deficit condition - management strategies for drought.
5. Tillage for rainfed crops – off-season tillage – primary tillage –secondary tillage – year round tillage – sub soiling – setline cultivation – modern concepts of tillage- minimum tillage and zero tillage.
6. 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
7. Management of crops in rainfed areas - Agronomic measures of soil and water conservation – choice of crop – crop geometry – tillage – contour cultivation – strip cropping – cover cropping – mulching – cropping systems and weed control - Mechanical measures of soil and water management.
8. Watershed – definition – concept— objectives and principles of water shed management components of watershed development programme – factors affecting watershed management.
9. Water harvesting – importance, its techniques- Water harvesting structures – arid region – runoff farming – water spreading – micro catchments – semi arid region – farm ponds, check dams – percolation tank – dug wells – life saving irrigation
10. *In-situ* moisture conservation measures – bund forming – bunding, ridge and furrow system – conservation furrows- inter plot water harvesting, mulching – Broad Bed and Furrow (BBF) and leveling.
11. Fertilizer use in rainfed areas – use of organic manures – introduction of legumes in crop rotation– organic recycling and bio-fertilizer use in rainfed agriculture – time and method of fertilizer application

12. Efficient crops and varieties – cropping systems in rainfed areas – intercropping – advantages – efficient inter cropping systems in different rainfed regions of Andhra Pradesh
13. Contingent crop planning for aberrant weather conditions in red and black soils.
14. Evapotranspiration – measures to reduce evapotranspiration – weeding, use of mulches, chemicals, windbreaks and shelterbelts
15. Land capability classification – alternate land use system
16. Efficient utilization of water through soil and crop management practices - agronomic measures - mechanical measures for soil and water conservation – gully control – bench terraces – contour terracing – graded bund

### **Practical**

1. Climate classification.
2. Rainfall analysis - Mean, standard deviation, variance and CV.
3. Onset and withdrawal of monsoons and determination of length of growing crop season.
4. Study on cropping pattern of different dryland areas.
5. Mapping of dryland areas in India.
6. Interpretation of meteorological data for rainfall variability.
7. Scheduling of supplemental irrigation based on crop ET demand.
8. Critical analysis of rainfall and calculation of wet spells, dry spells, and length of growing season.
9. Calculation of effective rainfall.
10. Determination of moisture availability index.
11. Study of cultural practices for mitigating moisture stress ( mulching, plant density, depth of sowing, thinning and leaf removal).
12. Visit to watershed.
13. Field demonstration on soil & moisture conservation measures.
14. Field demonstration of water harvesting structures.
15. Study of farm ponds as a source of supplemental irrigation.
16. Visit to rainfed research station.

### **References**

1. Reddy, S. R. and Prabhakar Reddy, G. 2015. Dryland Agriculture. Kalyani Publishers.
2. Arnon, I. 1972. Crop Production in Dry Regions (Vol.I), Leonard Hill Pub. Co, London.
3. Dhruva Narayana, V.V., Sastry, G.S. and Patnaiak, V.S. 1999. Watershed Management in India. ICAR, New Delhi.
4. Jeevananda Reddy, S. 2002. Dryland Agriculture in India: An agro-climatological and agro-meteorological perspective. B S publications.

**Course outlines****Theory**

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

**Practical**

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

**Lecture outlines****Theory**

1. Organic farming – definition – need – scope – principles – characteristics - relevance to modern agriculture.
2. Different eco friendly farming systems- biological farming, natural farming, regenerative agriculture – permaculture - biodynamic farming.
3. Relevance of organic farming to A.P, India, and global agriculture and future prospects- advantages - barriers.
4. Initiatives taken by the central and state governments, NGOs and other organizations for promotion of organic agriculture in India.
5. Organic nutrient sources and their fortification – organic manures- methods of composting
6. Green manures- bio fertilisers – types, methods of application – benefits and limitations.
7. Nutrient use in organic farming-scope and limitations.
8. Nutrient management in organic farming.
9. Organic ecosystem and their concepts.
10. Choice of crops and varieties in organic farming – crop rotations – need and benefits – multiple cropping.
11. Fundamentals of insect, disease and weed management under organic mode of production- cultural- biological methods-non chemical pest and disease management.
12. Botanicals- pyrethrum, neem seed kernel extract, neem seed powder, soluble neem formulations, neem oil.

13. Operational structure of NPOP – other agencies for organic production.
14. Inspection – certification - labelling and accreditation procedures for organic products.
15. Processing, - economic consideration and viability.
16. Marketing and export potential of organic products – national economy.

### **Practical**

1. Visit to organic farm to study the various components, identification and utilisation of organic products.
2. Compost making- aerobic and anaerobic methods
3. Vermicompost preparation
4. Preparation of enriched farm yard manure
5. Visit to organic clusters and bio control lab to study the maintenance of bio-fertilizers/bio-inoculant cultures
6. Biological nitrogen fixers.
7. Methods of application of Bio-pesticides (Trichocards, BT, NPV)
8. Preparation of neem products and other botanicals for pest and disease control
9. Preparation of green pesticides (panchagavya, beezamrutam, jeevamrutam, ghanajeevamrutam, dravajeevamrutam).
10. Different methods of biofertiliser applications.
11. Quality analysis of biofertilisers/bioinoculants and compost
12. Case studies of Indigenous Technical knowledge (ITK) for nutrient , insect, pest, disease and weed management
13. Economic analysis of organic production system
14. Study of post harvest management in organic farming
15. Study of quality parameters of organic produce
16. Visit to organic farms to study the various components and their utilization

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1. Arun K. Sharma. 2002. A Hand book of organic farming. Agrobios, India. 627p.
2. Palaniappan, S.P and Annadurai, K.1999. Organic farming-Theory and Practice. Scientific publishers, Jodhpur,India. 257p.
3. Mukund Joshi and Prabhakarasetty, T.K. 2006. Sustainability through organic farming. Kalyani publishers, New Delhi. 349p.
4. Balasubramanian, R., Balakishnan, K and Siva Subramanian, K. 2013. Principles and practices of organic farming. Satish Serial Publishing House. 453p

5. Tarafdar, J.C., Tripathi, K.P and Mahesh Kumar, 2009. Organic agriculture. Scientific Publishers, India. 369p.
6. Tiwari, V.N., Gupta, D.K., Maloo, S.R and Somani, L.L. 2010. Natural, organic, biological, ecological and biodynamic farming. Agrotech Publishing Academy, Udaipur. 420p.
7. Dushyent Gehlot. 2005. Organic farming- standards, accreditation, certification and inspection. Agrobios, India. 357p

**Course outlines****Theory**

Pre-Mendelian concepts of heredity; Mendelian principles of heredity; Cell division – mitosis and meiosis; Probability and Chi-square; Dominance relationships; Gene interaction; Multiple factor hypothesis; Epistatic interactions with examples; Multiple alleles; Linkage and its estimation; Crossing over mechanisms; Chromosome mapping; Pleiotropism and Pseudoalleles; Sex determination and sex linkage; sex limited and sex influenced traits; Structural changes in chromosome; Mutation- classification, mutagenic agents and methods of inducing mutation and CIB technique. Qualitative & quantitative traits; Polygenes and continuous variations; Cytoplasmic inheritance; Gene concept: Gene structure, function and regulation (eg. Lac operon); Nature, structure & replication of genetic material; Protein synthesis- Transcription and translational mechanisms of genetic material.

**Practical**

Study of microscope; Study of cell structure; Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross; Experiments on epistatic interactions including test cross and back cross; Practice on mitotic and meiotic cell division; Experiments on probability and Chi-square test; Determination of linkage and cross over analysis (through two point test cross and three point test cross data); Study of models on DNA and RNA structure.

**Lecture outlines****Theory**

1. Pre Mendelian concepts of heredity – Early history of heredity, inheritance of acquired traits, preformation theory, pangenesis and germplasm theory.
2. Chromosome - Structure of chromosome, types of chromosomes based on position of centromere.
3. Cell division – Cell cycle – Mitosis - Process of mitosis - Significance.
4. Meiosis - Process - Differences between mitosis and meiosis - Significance.
5. Mendelian principles of heredity – Terminology, Mendel's experiments - Reasons for selection of pea as experimental material- characters studied - Reasons for mendel's success.
6. 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.
7. Probability and Chi-square – Concept of probability, predicting results of a monohybrid cross, predicting results of a dihybrid cross - Chi-square test.
8. Dominance relationships – Complete dominance, incomplete dominance, co-dominance, over dominance, pseudodominance, lethal factors.

9. Gene interaction - Nonepistatic interaction – Interaction of factors; epistatic interactions – Complementary epistasis, dominant epistasis.
10. Recessive epistasis, duplicate dominant gene action, dominant suppression or inhibitory gene action, duplicate genes with cumulative effect.
11. Multiple alleles – Characteristics of multiple alleles - Blood groups in humans, coat colour in rabbits, self incompatibility alleles in plants - pleiotropism, penetrance and expressivity.
12. Linkage – Definition – Classification of linkage – Characteristic features of linkage – Linkage groups.
13. Detection of linkage – Estimation of linkage - Importance of test cross in linkage studies - significance in plant breeding.
14. Crossing over mechanisms - Mechanism of crossing over – Types of crossing over – Factors affecting crossing over.
15. Significance of crossing over in plant breeding - Cytological proof of crossing over in *Drosophila*.
16. Chromosome mapping - 2-point and 3-point test cross – Cytological maps and genetical maps – Coincidence and interference.
17. Sex determination – Various mechanisms of sex determination – Chromosomal sex determination, genic balance mechanism of sex determination in *Drosophila melanogaster*, male haploidy, single gene effects etc.
18. Sex linkage – White eye colour in *Drosophila*, colour blindness and haemophilia in humans - sex influenced traits – Horns in sheep, baldness in humans, sex limited - Milk production in cattle, beard in man – Pseudohermaphrodites – Gynandromorphs.
19. Qualitative and Quantitative traits, Polygenes and continuous variations - Definition - Inheritance and their differences, multiple factor hypothesis.
20. 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 extrachromosomal inheritance.
21. Nature and structure of genetic material - DNA and its structure -Watson and Crick's model - Function – Experiments to prove DNA as genetic material.
22. Replication of DNA - Modes of DNA replication - Semi-conservative DNA replication - Experimental proof.
23. -Types of RNA - Messenger RNA, ribosomal RNA and transfer RNA - structure of tRNA, differences between DNA and RNA.
24. Protein synthesis – Central dogma, transcription and translational mechanism of genetic material - Genetic code – Properties of genetic code – Wobble hypothesis.
25. Steps in protein synthesis - Transcription and translation.
26. Gene regulation - Lac operon concept – Gene concept – Cistron – Recon – Muton.

27. Mutation - Classification - Gene mutations - Introduction - Definition - Types of mutations - Spontaneous and induced mutations - Point mutations - Characters of mutations - Xenia and metaxenia – Chimeras Types and their significance in plant breeding.
28. Methods of inducing mutations, Physical and chemical mutagens - Detection of sex linked lethals in *Drosophila* (CIB method given by Muller).
29. Molecular basis of mutations - Transitions, transversions and frame shift mutations - Importance of mutations in plant breeding.
30. Structural changes in chromosome - Breakage - fusion - bridge cycle - Deletions (deficiency) - Duplications and their significance in plant breeding.
31. Inversions - pericentric inversions and paracentric inversions - inversions as cross over suppressors.
32. Translocations - simple and reciprocal - their role in plant breeding.

### **Practical**

1. Study of microscope.
2. Study of cell structure.
3. Practice on mitotic cell division.
4. Practice on meiotic cell division.
5. Practice on meiotic cell division.
6. Probability and Chi-square test.
7. Monohybrid and its modifications.
8. Dihybrid.
9. Trihybrid.
10. Test cross and back cross.
11. Epistatic interactions including test cross and back cross.
12. Epistatic interactions including test cross and back cross.
13. Epistatic interactions including test cross and back cross.
14. Determination of linkage and cross over analysis (through two point test cross data).
15. Determination of linkage and cross over analysis (through three point test cross data).
16. Study of models on DNA and RNA structure.

### **References**

1. Pundhan Singh. 2006. *Genetics*. Kalyani Publishers, Ludhiana.
2. Singh, B.D. 2015. *Fundamentals of Genetics*. Kalyani Publishers, Ludhiana.
3. Gupta, P.K.2007. *Genetics*. Rastogi Publications, Meerut.
4. Khanna, V.K. 2002. *Genetics Numerical Problems*. Kalyani publishers. 2nd edition.

5. Punthhan Singh. 2011. *Genetics at a Glance*. Kalyani Publishers, Ludhiana.
6. Verma , P.S. and Agarwal, P.K. 2013. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand & Company Pvt. Ltd., Kolkata.
7. Snustad , D.P. and Simmons, M.J. 2010. *Principles of Genetics*. 5<sup>th</sup> Ed. John Wiley & Sons, 111, River Street, Hoboken, NJ, U.S.A.
8. Strickberger, M.W. 2006. *Genetics*. Prentice – Hall of India Pvt. Ltd., New Delhi.

**GPBR 211**

**FUNDAMENTALS OF PLANT BREEDING**

**3(2+1)**

### **Course outlines**

#### **Theory**

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding; Heritability and genetic advance; modes of reproduction and apomixes; self – incompatibility and male sterility- genetic consequences, cultivar options; Domestication, Acclimatization, introduction, Centre of origin/diversity; Genetic basis and breeding methods in self-pollinated crops-mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept; Concepts of population genetics and Hardy-Weinberg Law; Genetic basis and methods of breeding cross pollinated crops, modes of selection; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Wide hybridization and pre-breeding; Polyploidy in relation to plant breeding; mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding.

#### **Practical**

Plant Breeder's kit; Study of germplasm of various crops; Study of floral structure of self-pollinated and cross pollinated crops; Emasculation and hybridization techniques in self & cross pollinated crops; Consequences of inbreeding on genetic structure of resulting populations; Study of male sterility system; Handling of segregation populations; Methods of calculating mean, range, variance, standard deviation. Designs used in plant breeding experiment, analysis of Randomized Block Design; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Work out the mode of pollination in a given crop and extent of natural out crossing; Prediction of performance of double cross hybrids.

### **Lecture outlines**

#### **Theory**

- 1 Historical developments, concept, nature and role of plant breeding, major achievements and future prospects - 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 and apomixis - Asexual reproduction (vegetative reproduction and apomixis) and sexual reproduction - Their classification and significance in plant breeding.
- 3 Modes of pollination - Classification of crop species on the basis of mode of pollination– self pollination – mechanisms promoting self pollination – Genetic consequences of self pollination – Cross pollination – Mechanisms promoting cross pollination – Genetic consequences of cross pollination – Often cross pollinated crops.
- 4 Self- incompatibility - Classification – Heteromorphic, homomorphic, gametophytic and sporophytic systems of incompatibility – Advantages and disadvantages – Utilization in crop improvement.
- 5 Male sterility- Genetic consequences, cultivar options - Different types – Genetic, cytoplasmic and cytoplasmic genetic male sterility – Inheritance and maintenance– utilization of male sterile lines in hybrid seed production – Their advantages and disadvantages.
- 6 Domestication, acclimatization and introduction - 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.
- 7 Centre of origin/diversity - Centres of diversity– Centres of origin – Classification – law of homologous series – Types of centres of diversity – Germplasm collections – Genetic erosion – Main reasons of genetic erosion – Extinction - Gene sanctuaries - Introgression – Gene banks – Types of gene banks.
- 8 Breeding methods in self pollinated crops - Modes of selection - Selection – Natural and artificial selection – Basic principles of selection – Basic characteristics and requirements of selection – Selection intensity – Selection differential, heritability (narrow and broad sense) – Genetic advance as per cent of mean.
- 9 Mass selection – Procedure for evolving a variety by mass selection – Modification of mass selection – Merits, demerits and achievements.
- 10 Pure line selection - Johannsen's pure line theory and its concepts and significance – Origin of variation in pure lines – Characters of pure lines – Progeny test, genetic basis of pure line selection – General procedure for evolving a variety by pure line selection – Merits, demerits and achievements – Comparison between mass and pure line selection.
- 11 Hybridization techniques - Hybridization – Aims and objectives – Types of hybridization – Pre-requisites for hybridization – Procedure / steps involved in hybridization.
- 12 Handling of segregating population - Pedigree method – Procedure – Merits, demerits and achievements.
- 13 Bulk method – Procedure – Merits, demerits and achievements – Comparison between pedigree and bulk methods - Single seed descent method – Merits and demerits.

- 14 Backcross method of breeding–Its requirements and applications – Procedure for transfer of single dominant gene - Procedure for transfer of single recessive gene – Merits, demerits and achievements - comparison between pedigree and backcross method.
- 15 Multiline concept - Definition – Characteristics of a good multiline – Development of multiline varieties – Achievements.
- 16 Concepts of population genetics and Hardy - Weinberg Law - Hardy Weinberg Law – Factors affecting equilibrium frequencies in random mating populations - Selection without progeny testing – Selection with progeny testing - Merits and demerits of progeny selection – Line breeding– achievements.
- 17 Recurrent selection – Different types – Detailed procedure of simple recurrent selection and other recurrent selection methods – Conclusion on the efficiency of different selection schemes.
- 18 Heterosis - Heterosis and hybrid vigour – Luxuriance – Heterobeltiosis – Brief history– heterosis in cross pollinated and self pollinated species – Manifestations of heterosis-
- 19 Genetic basis of heterosis – Dominance, over dominance and epistasis hypotheses – Objections and their explanations – Comparison between dominance and over-dominance hypotheses – Physiological basis of heterosis – Commercial utilization.
- 20 Inbreeding depression - Brief history – Effects of inbreeding – Eegrees of inbreeding depression – Procedure for development of inbred lines and their evaluation.
- 21 Development of inbred lines and hybrids - Exploitation of heterosis – History of hybrid varieties – Important steps in production of single and double cross hybrids – Brief idea of hybrids in maize, pearl millet, sunflower and rice.
- 22 Composite and synthetic varieties - Production procedures – Merits, demerits and achievements – Factors determining the performance of synthetic varieties – Comparison between synthetics and composites.
- 23 Breeding methods in asexually propagated crops, clonal selection and hybridization - Characteristics of asexually propagated crops – Characteristics of clones –Clonal selection – Procedure – Advantages and disadvantages – Problems in breeding asexually propagated crops – Genetic variation within a clone – Clonal degeneration – Achievements – Comparison among clones, purelines and inbreds - Breeding of annual asexually propagated species through hybridization – Interspecific hybridization.
- 24 Wide hybridization and pre breeding - History – Objectives – Barriers for the production of distant hybrids– Techniques for production of distant hybrids – applications of wide hybridization in crop improvement – Sterility in distant hybrids – Limitations and achievements -use of gene pools to develop intermediate breeding material.
- 25 Polyploidy in relation to plant breeding - Polyploidy – Autopolyploids – Origin and production – Morphological and cytological features– Applications in crop improvement – Limitations– Allopolyploidy – Morphological and cytological features– Applications in crop improvement – Limitations.

- 26 Mutation breeding - Methods and uses - Mutation breeding – Procedure of mutation breeding – Applications – Advantages, limitations and achievements.
- 27 Breeding for important biotic and abiotic stresses - Disease resistance – Mechanisms of disease resistance in plants (disease escape, tolerance, resistance, immunity and hypersensitivity) – Genetic basis of disease resistance – Gene for gene hypothesis – sources of disease resistance – Breeding methods for disease resistance – Achievements.
- 28 Insect resistance – Mechanism of insect resistance in plants (non preference, antibiosis, tolerance and avoidance) – Nature of insect resistance – Genetics of insect resistance – Horizontal and vertical resistance– Sources of insect resistance – breeding methods for insect resistance – Problems in breeding for insect resistance – Achievements.
- 29 Drought resistance – Mechanisms of drought resistance (drought escape, avoidance, tolerance, and resistance) – Features associated with drought resistance – Sources of drought resistance – Breeding methods for drought resistance – Limitations – achievements - Resistance to water logging – Effects of water logging - Mechanism of tolerance – Ideotype for flooded areas.
- 30 Salt tolerance – Response of plants to salinity – Symptoms – Mechanisms of salt tolerance – Breeding methods for salt tolerance – Problems – Achievements. Cold tolerance – Chilling resistance – Effects of chilling stress on plants – Mechanism of chilling tolerance – Sources of chilling tolerance – Selection criteria.
- 31 Biotechnological tools - DNA markers and marker assisted selection - Definition and classification of DNA markers and applications.
- 32 Participatory plant breeding - Definition – Goals – Methodology – Advantages and limitations.

### **Practical**

- 1 Plant Breeder's kit.
- 2 Study of germplasm of various crops.
- 3 Emasculation and hybridization techniques in self pollinated crops – rice, groundnut.
- 4 Emasculation and hybridization techniques in self pollinated crops – greengram, sesame.
- 5 Emasculation and hybridization techniques in cross pollinated crops – maize, castor.
- 6 Emasculation and hybridization techniques in often cross pollinated crops – cotton, redgram.
- 7 Consequences of inbreeding on genetic structure of resulting populations.
- 8 Study of male sterility systems.
- 9 Handling of segregation populations.

- 10 Methods of calculating mean, range, variance, standard deviation.
- 11 Designs used in plant breeding experiments.
- 12 Layout of field experiment.
- 13 Analysis of Randomized Block Design.
- 14 Estimation of heterosis, inbreeding depression and heritability.
- 15 Prediction of performance of double cross hybrids.
- 16 Work out the mode of pollination in a given crop and extent of natural out crossing.

### References

1. Phundan Singh, 2014. *Essentials of Plant Breeding*. Kalyani Publishers, New Delhi.
2. Singh, B.D. 2015. *Plant Breeding: Principles and Methods*. Kalyani Publishers, New Delhi.
3. Gupta, S.K. 2010. *Plant Breeding Theory and Techniques*. Wiley India Pvt. Ltd. New Delhi.
4. Allard, R.W. 2010. *Principles of Plant Breeding*. John Wiley and Sons, New York.
5. Poehlman, J.M. and Borthakur, D. 1995. *Breeding of Asian Field Crops*. Oxford and IBH Publishing Co., New Delhi.
6. Sharma, J.R. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw Hill, Publishing Company Ltd., New Delhi.

**GPBR 311**

**CROP IMPROVEMENT - I  
(CEREALS, MILLETS, PULSES AND OILSEEDS)**

**2 (1+1)**

### Course outlines

#### Theory

Centers of origin, distribution of species, wild relatives in different cereals, pulses, oilseeds; Plant genetic resources, its utilization and conservation; Floral biology; study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Ideotype concept and climate resilient crop varieties for future.

#### Practical

Emasculation and hybridization techniques in different crop species; cereals, millets, pulses and oilseeds. Maintenance breeding of different crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

## Lecture outlines

### Theory

- 1 Introduction – General Breeding Objectives – Concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops - Breeding populations-relevance in crop improvement.
- 2 Cereals - Rice - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids-Accomplishments.
3. Cereals - Wheat and Barley - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
4. Millets - Sorghum and Pearl millet - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 5 Millets - Finger millet, Kodo millet and Proso millet - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids-Accomplishments.
- 6 Pulses - Chickpea - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids-Accomplishments.
- 7 Pulses - Pigeonpea - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 8 Pulses - Urd bean and Mung bean - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
9. Pulses - Soybean and Cowpea - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 10 Pulses - Horsegram, Fieldpea and Lentil - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional

and modern innovative approaches) for development of hybrids / varieties-seed production technology of varieties and hybrids –Accomplishments.

- 11 Oilseeds - Groundnut- Origin – Distribution of species – Wild relatives and forms – breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids-Accomplishments.
- 12 Oilseeds - Castor and Sesame - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 13 Oilseeds - Sunflower and Safflower - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 14 Oilseeds - Rapeseed and Mustard - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 15 Oilseeds - Linseed and Niger - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 16 Oilseeds - Coconut and Oilpalm - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.

### **Practical**

1. Hybridization techniques and precautions to be taken, Floral morphology, selfing, emasculation and crossing techniques in field crops
2. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in rice.
3. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Wheat and Barley.
4. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Maize and Sorghum.
5. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Pearl millet and Finger millet.

6. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Kodo millet and Proso millet.
7. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Chickpea and Pigeonpea.
8. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Urdbean and Mungbean.
9. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Soybean and Cowpea.
10. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Groundnut and Castor.
11. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Sesame and Linseed.
12. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Rapeseed and Mustard.
13. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Sunflower and Safflower.
14. Visit to Agricultural Research stations/AICRP projects of crops.
15. Sources of donors for different characters in various crops & Parentage of released varieties / hybrids of important crops.
16. Study of special quality characters in various crops.

## REFERENCES

1. Allard, R.W. 1960. *Principles of Plant Breeding*. John Wiley & Sons, New York.
2. Phundan Singh. 2006. *Essential of Plant Breeding*. Kalyani Publishers, Ludhiana.
3. Poehlman, J.M. and Borthakur, D. 1995. *Breeding of Asian Field Crops*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Sharma, J.R. 1994. *Principles and Practices of Plant Breeding*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
5. Kalloo, G. 1994. *Vegetable Breeding*. Panima Educational Book Agency, New Delhi.
6. Kumar, N. 2006. *Breeding of Horticultural Crops-Principles and Practices*. New India Publishing Agency, New Delhi.
7. George Acquaah. 2012. *Principles of Plant Genetics and Breeding*. Blackwell Publishing Ltd., USA.
8. Mono graphs available on specific crops.

**Course outlines****Theory**

Centers of origin, distribution of species, wild relatives in different fibres, sugars, starches, narcotics, vegetables, fruits and flower crops. Plant genetic resources, its utilization and conservation; Floral biology; study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Ideotype concept and climate resilient crop varieties for future.

**Practical**

Emasculation and hybridization techniques in fibres, sugars, starches, narcotics, vegetables, fruits and flower crops; maintenance breeding of different crops; Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

**Lecture outlines****Theory**

- 1 Introduction – General breeding objectives – Concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops - Breeding populations- relevance in crop improvement.
- 2 Fibres - Cotton and Jute- Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
3. Sugars and starches – Sugarcane - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
4. Sugars and starches – Potato and sweet potato - Origin – Distribution of species – wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 5 Narcotics - Tobacco- Origin – Distribution of species – Wild relatives and forms – breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.

- 6 Vegetables - Tomato and Brinjal - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 7 Vegetables - Chilli and Okra - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 8 Vegetables-Cucumber , Cabbage and cauliflower - Origin – Distribution of species – wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
9. Vegetables - Garlic and Onion - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 10 Vegetables - Gourds and Melons- Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 11 Fruit crops - Banana and Guava - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 12 Fruit crops-Mango and Papaya - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - seed production technology of varieties and hybrids - Accomplishments.
- 13 Fruit crops - Lime , Lemons and Apple - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.
- 14 Fruit crops - Pomegranate and Sapota - Origin – Distribution of species – Wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids – Accomplishments.
- 15 Flower crops - Rose and Jasmine - Origin – Distribution of species – Wild relatives and forms – Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.

- 16 Flower crops - Chrysanthemum and Marigold - Origin – Distribution of species – wild relatives and forms –Breeding objectives – Major breeding procedures (conventional and modern innovative approaches) for development of hybrids / varieties - Seed production technology of varieties and hybrids - Accomplishments.

### **Practical**

1. Hybridization techniques and precautions to be taken - Floral morphology, selfing, emasculation and crossing techniques in field crops.
2. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Cotton and Jute.
3. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Sugarcane and Tobacco.
4. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Tomato and Brinjal.
5. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Chilli and Okra.
6. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in and Cucumber, Cabbage and Cauliflower.
7. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Garlic and Onion.
8. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Bitter gourd and Water melon.
9. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Banana and Mango.
10. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Papaya and Guava.
11. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Lime and Lemon.
12. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Rose and Jasmine.
13. Floral biology, anthesis, pollination, selfing, emasculation and crossing techniques in Marigold and Chrysanthemum.
14. Visit to Agricultural Research stations/AICRP Centres of crops.
15. Sources of donors for different characters in various crops & Parentage of released varieties / hybrids of important crops.
16. Study of special quality characters in various crops.

### **References**

1. Allard, R.W. 1960. *Principles of Plant Breeding*. John Wiley & Sons, New York.
2. Phundan Singh. 2006. *Essential of Plant Breeding*. Kalyani Publishers, Ludhiana.

3. Poehlman, J.M. and Borthakur, D. 1995. *Breeding of Asian Field Crops*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Sharma, J.R. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
5. Kalloo, G.1994. *Vegetable Breeding*. Panima Educational Book Agency, New Delhi.
6. Kumar, N. 2006. *Breeding of Horticultural Crops - Principles and Practices*. New India Publishing Agency, New Delhi.
7. George Acquaah..2012. *Principles of Plant Genetics and Breeding*. Blackwell Publishing Ltd., USA.

**GPBR 313**

**INTELLECTUAL PROPERTY RIGHTS**

**1(1+0)**

### **Course outlines**

#### **Theory**

Introduction and meaning of intellectual property; brief introduction to GATT, WTO, TRIPs and WIPO; Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.;Types of Intellectual Property and legislations covering IPR in India: Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets; Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database; Origin and history including a brief introduction to UPOV for protection of plant varieties; Protection of plant varieties under UPOV and PPV&FR Act of India; Plant breeders rights; Registration of plant varieties under PPV&FR Act 2001; breeders, researcher and farmers rights; Traditional knowledge-meaning and rights of TK holders; Convention on Biological Diversity; International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

### **Lecture outlines**

#### **Theory**

- 1 Introduction and meaning of intellectual property.
- 2 Brief introduction to GATT, WTO, TRIPs and WIPO.
- 3 Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.
- 4-6 Types of Intellectual Property and legislations covering IPR in India: Patents and Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets.
- 7 Patents Act 1970.
- 8 Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database

- 9 Origin and history including a brief introduction to UPOV for protection of plant varieties.
- 10 Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders rights.
- 11 Registration of plant varieties under PPV&FR Act, 2001.
- 12 Breeders, researcher and farmers rights.
- 13 Traditional knowledge-meaning and rights of TK holders.
- 14 Convention on Biological Diversity.
- 15 International treaty on plant genetic resources for food and agriculture (ITPGRFA).
- 16 Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

### References

1. Acharya, N.K. 2014. *Text book of Intellectual Property Rights*. Asia Law House, Hyderabad.
2. Loganathan, E.T. 2012. *Intellectual Property Rights*. New Century Publications, New Delhi.
3. Rosedar, S.R.A. 2016. *Intellectual Property Rights*. Lexis Nexis (2<sup>nd</sup> Ed.), Nagpur.

**GPBR 314**

**PRINCIPLES OF SEED TECHNOLOGY**

**3 (2+1)**

### Course outlines

#### Theory

Seed and seed technology: introduction, definition and importance; Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed; Foundation and certified seed production of important cereals, pulses, oilseeds, fiber crops; Seed certification, phases of certification, procedure for seed certification, field inspection; Seed Act and Seed Act enforcement; Duty and powers of seed inspector, offences and penalties; Seeds Control Order 1983, Varietal Identification through Grow Out Test and Electrophoresis, Molecular and Biochemical test; Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production.

Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing; Seed storage: general principles, stages and factors affecting seed longevity during storage; Measures for pest and disease control during storage; Seed marketing: structure and organization, sales generation activities, promotional media; Factors affecting seed marketing, Role of WTO and OECD in seed marketing.

## **Practical**

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

## **Lecture outlines**

### **Theory**

1. Introduction to seed and seed technology – Definitions and importance – Roles and goals of seed technology - Differences between scientifically produced seed and grain used as seed.
2. Seed quality - Definition, characters of good quality seed - Different classes of seed -Seed generation systems - Seed multiplication ratios - Seed replacement rate.
3. Deterioration of crop varieties – Factors responsible for loss of genetic purity- Safeguards for maintenance of genetic purity.
4. Maintenance of genetic purity during seed production in self pollinated and cross pollinated crops.
5. History and development of seed industry- seed production organizations-National Seed Corporation (NSC) - Andhra Pradesh State Seed Development Corporation (APSSDC) - Andhra Pradesh State Seed Certification Agency (APSSCA) and their functions.
6. Seed certification – History of seed certification – Procedure for seed certification and field inspection- Recognition of seed certification agencies of foreign countries.
7. Foundation and certified seed production of varieties and hybrids in rice.
8. Foundation and certified seed production of varieties and hybrids in maize.
9. Foundation and certified seed production of varieties and hybrids in sorghum and pearl millet.
10. Foundation and certified seed production of varieties in groundnut, sesamum and varieties hybrids in sunflower and castor.
11. Foundation and certified seed production of varieties in blackgram, greengram and bengalgram and varieties and hybrids in redgram.
12. Foundation and certified seed production of varieties and hybrids in cotton.
13. Foundation and certified seed production of varieties and hybrids in mesta and sunhemp.
14. Organic seed production – Importance - Problems and perspectives for production of quality seeds.

- 15 & 16 Varietal Identification through Grow Out Test - Electrophoresis, molecular and biochemical tests.
17. Detection of genetically modified crops- Transgene contamination in non-GM crops, GM crops and organic seed production.
  18. Planning, layout and establishment of seed processing plant – Factors to be considered in planning and designing a seed processing plant – Types of layouts.
  19. Seed drying, seed processing and their steps, seed drying – Methods of seed drying – Sun drying – Forced air drying – Principle of forced air drying – Moisture equilibrium between seed and air.
  20. Drying zones in seed bin drying – Forced air drying method– Heated air drying system – Building requirements – Types of air distribution system and seed drying – Multiple bin storages.
  21. Selection of crop dryers and systems of heated air drying – Recommended temperature and depth for heated air drying of various crop seeds in bin – Management of seed drying operations.
  22. Seed cleaning –Pre cleaning and preconditioning equipments - Principle and method of seed cleaning – Air screen machine – Principle of cleaning – Parts of air screen cleaner.
  23. Upgrading the quality of cleaned seeds - Different upgrading machines, their principles of operation and uses.
  24. Seed treatment, its importance– Types of seed treatment and their benefits and method of application – Pre sowing treatments - Equipments used for seed treatment.
  25. Seed coating – Seed pelleting and seed invigoration –Precautions to be taken during seed treatment.
  26. Seed packaging – Operations in packaging – Equipments used for packaging of seeds– Types of packing material and packing size.
  27. Seed storage- Categories of seeds – Orthodox and recalcitrant seeds – Factors affecting seed longevity in storage and conditions required for good storage – General principles of seed storage, general principles, stages and factors affecting seed longevity during storage; measures for pest and disease control during storage
  28. Seed marketing, structure and organization, sales generation activities, promotional media, factors effecting seed marketing - Role of WTO and OECD in seed marketing.
  29. Seed Act - Main features of the Seed Act, 1966 and Seed Act enforcement - Duties and powers of seed inspector - Offences and penalties - Seeds Control Order 1983- features of New Seed Bill, 2004.
  30. Central Seed Committee – Central Seed Certification Board – State Seed Certification Agency – Central Seed Testing Laboratory – State Seed Testing Laboratory – Appellate Authority.

31. Notification of standards and procedures – Notification of variety – Regulation of sale of notified varieties – Requirements for sale of seed.
32. Seed testing for quality assessment, seed testing – Objectives of seed testing – International Seed Testing Association (ISTA) and – Establishment of Seed Testing Laboratory (STL) – Seed testing procedures for quality assessment.

### **Practical**

1. Seed production in cereals (Wheat, Rice, Maize, Sorghum and Bajra)
2. Seed production in pulses (Redgram, Blackgram, Greengram and Bengalgram)
3. Seed production in oilseeds (Groundnut, Sesame, Sunflower and Castor)
4. Seed certification - Procedure, field inspection - preparation of field inspection report.
5. Seed sampling – Principles and procedures
6. Physical purity analysis of field crops and vegetable crops.
7. Germination analysis of field crops and vegetable crops.
8. Seed moisture tests of field crops and vegetable crops.
9. Seed viability test of field crops and vegetable crops.
10. Seed dormancy- Types of dormancy- methods of breaking dormancy.
11. Seed vigour tests of field crops and vegetable crops.
12. Seed health testing of field crops and vegetable crops.
13. Grow out test (GOT) and electrophoresis for varietal identification.
14. Visit to seed testing laboratories (STLs).
15. Visit to seed processing plant.
16. Visit to seed production farm.

### **References**

1. Agarwal, P.K. 1994. *Principles of Seed technology*. ICAR, New Delhi.
2. Agarwal, P.K. and Dadlani, M. 1986. *Techniques in Seed Science and Technology*. South Asian Publishers, New Delhi.
3. Agarwal, R.L. 1995. *Seed Technology*. Oxford and IBH Publication Co., New Delhi.
4. Dhirendra Khare and Mohan S. Bhale. 2007. *Seed Technology*. Scientific Publishers (India), Jodhpur.
5. Thomson, J.R. 1979. *An introduction of Seed Technology*. Leonard Hill, London.

**Course outlines****Theory**

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: Soil-texture, structure, density and porosity, Soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention, movement and availability; soil air, composition, gaseous exchange, problem and plant growth; source, amount and flow of heat in soil; soil temperature and plant growth; Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; Soil colloids - inorganic and organic; silicate clays: constitution and properties; sources of charge ion exchange, cation exchange capacity, base saturation; Soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

**Practical**

Study of soil profile in field. Study of soil sampling tools, collection of representative soil sample, its processing and storage. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil, Infiltration rate. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Determination of soil colour. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

**Lecture outlines****Theory**

1. 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 –igneous rocks, sedimentary rocks and metamorphic rocks – Classification of rocks based on silica content – Weatherability of rocks.
3. Minerals – Primary, secondary, essential and accessory minerals – Primary minerals – Quartz, feldspar, micas, pyroxenes, amphiboles and olivines – Weatherability of primary minerals.
4. 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. Parent material – Classification of parent materials based on their mode of transport by different agents - Soil formation – Soil forming factors – Classification and their role in soil formation – Catena – Definition.
8. Pedogenic processes – Eluviation, illuviation, humification, calcification, laterization, podzolisation, melanisation, salinization and alkalization.
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 consistence – Consistence of wet and dry soils – Soil crusting – Soil plasticity – Atterberg's plastic limits – Factors affecting plastic limits – Significance of soil consistence.
13. Soil structure – Classification – Types, classes and grades of soil structure – Importance of soil structure and its management.
14. Soil density – Bulk density and particle density – Factors affecting density parameters – Importance of bulk density of soil – Soil compaction – its importance – Calculation of porosity.
15. Soil strength and its importance – Soil colour – Components – Significance of soil colour.
16. Soil water – Forces of soil water retention – pF concept – Soil moisture characteristic curves – Importance of soil water.
17. 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.
18. Soil 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.
19. 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.

20. Soil air – Compositions of atmospheric air and soil air – Gaseous exchange – Influence of soil air on plant growth, soil properties and nutrient availability – Measurement of oxygen diffusion rate – Measures to improve soil aeration.
21. Soil reaction, pH, soil acidity and alkalinity, buffering, 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 of different types – 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. Soil organic matter and humus – Importance – 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.
31. Soil taxonomy – Order, sub order, great group and family series – Nomenclature according to soil taxonomy.
32. Soil groups of India – Alluvial soils, black soils, red soils, laterite soils and coastal sands.

### **Practicals**

1. Methods of chemical analysis, principles, techniques and calculations
2. Study of soil sampling tools, collection of representative soil sample, its Processing and storage.
3. Description of soil profile in the field.
4. Studies of capillary rise phenomenon of water in soil column and water movement in soil.

5. Determination of texture by feel method.
6. Determination of mechanical composition of soil using Bouyoucos Hydrometer.
7. Determination of bulk density and particle density of soil and porosity.
8. Determination of soil moisture content by gravimetric method.
9. Determination of infiltration rate.
10. Determination of soil strength by cone penetrometer.
11. Aggregate analysis by wet sieving method.
12. Determination of soil pH & EC of soil.
13. Determination of cation exchange capacity of soil.
14. Determination of soil colour & study of soil map.
15. Estimation of organic matter content in soil.
16. Determination of heat transfer in soils.

### References

1. Indian Society of Soil Science. 2012. *Fundamentals of Soil Science*, IARI, New Delhi.
2. Das, D. K .2015. *Introductory Soil Science*, 4<sup>th</sup> Edition, Kalyani Publishers, New Delhi
3. Sehgal,J. 2015. *A Text Book of Pedology – Concepts and Applications*, Kalyani Publishers,New Delhi.

**SSAC 221**

### **MANURES, FERTILIZERS AND SOIL FERTILITY MANAGEMENT**

**3(2+1)**

#### **Course outlines**

#### **Theory**

Introduction, traditional concepts and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Integrated nutrient management. Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, Nano fertilizers, Soil amendments, Fertilizer Storage, Fertilizer Control Order. History of soil fertility and plant nutrition. Criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients. Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rain fed and irrigated conditions.

## Practical

Introduction of analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of available N in soils. Estimation of available P in soils. Estimation of available K in soils. Estimation of available S in soils. Estimation of available Zn in soils. Estimation of N in plants. Estimation of P in plants. Estimation of K in plants. Estimation of S in plants. Determination of N, P and K in fertilizers, Identification of fertilizer radicals, Nitrogen estimation in organic manure.

## Lecture outlines

### Theory

1. Introduction - History of soil fertility and plant nutrition - Concepts of soil fertility, soil productivity, Navadhanya and Annapurna concepts in relation to soil fertility- Soil as a source of plant nutrients - Nutrient Elements - Arnon's criteria of essentiality – Essential, functional and beneficial elements.
2. Scientists responsible for the essentiality of nutrients -Ionic forms of plant nutrients in soil – Mechanism of nutrient transport - Movement of ions from soils to roots – Mass flow, diffusion, root interception and contact exchange.
3. Essential nutrients – Classification and their functions in plants.
4. Deficiency symptoms of nutrients - Corrective measures – Toxicity symptoms of different nutrients.
5. 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.
6. 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.
7. 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.
8. Potassium - Content in soil – Source – Forms of soil potassium - Potassium fixation - Factors affecting potassium fixation – Quantity and Intensity parameters – Luxury consumption.
9. 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.
10. 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.

11. Micronutrient - Sources – Forms in soil solution – Pools of micronutrients – Predisposing factors for occurrence of micronutrient deficiencies in soil and plants
12. Zn and Mn - Content – Forms in soils – Critical limits in soils and plants - Factors affecting their availability.
13. Fe and Cu - Content – Forms in soils – Critical limits in soils and plants. Factors affecting their availability.
14. Boron and Molybdenum - Content – Forms in soil - Critical limits in soils and plants. Factors affecting their availability.
15. Chlorine - Content – Forms in soils – Critical limits in soils and plants. Factors affecting its availability – Beneficial Elements- Sodium, Cobalt, Vanadium and Silicon
16. Soil fertility Evaluation: - Approaches – Soil testing – Objectives of soil testing – Chemical methods for estimating available nutrients.
17. Plant analysis – Rapid tissue tests – Indicator plants - Biological methods of soil fertility evaluation, A- value – Microbiological methods – Sackett and Stewart techniques – Mehlich technique – Cunninghamella plaque method – Mulder's *Aspergillus niger* technique – Mistcherlich's pot culture method.
18. Soil test based fertilizers recommendation:- Critical nutrient concept (Cate and Nelson) – Critical levels of nutrients in soils - General recommendations Use of empirical equations for scheduling fertilizer doses - Targeted yield approach
19. Nutrient use efficiency:- Soil, plant and management factors influencing Nutrient use efficiency in respect of N, P, K, S, Fe and Zn fertilizers – Foliar application – Fertigation – Liquid fertilizers.
20. Methods of application of nutrients under rainfed and irrigated conditions
21. Introduction and 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.
22. 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.
23. Compost and composting – Different methods of composting including the starters and raw materials
24. Methods of preparation of rural and urban compost. Mechanical compost plants – Their advantages over conventional composting –Vermi-composting
25. Green manures – Classification with examples. Advantages and limitations of green manuring and green leaf manuring. Biogas plant – Principles of operation and its advantages.
26. Definitions of penning, sewage, sewerage, sullage, poudrette, Activated compost process. Concentrated organic manures – Oil cakes, blood meal, bone meal, horn meal, fish meal, meat meal and guano.

27. Chemical fertilizers – Classification with examples – Nitrogenous fertilizers – composition and properties of major nitrogenous fertilizers viz., Ammonium sulphate, urea and calcium ammonium nitrate.
28. Phosphatic fertilizers – Composition of Rock phosphate – Occurrence, types and properties- properties of SSP, TSP and basic slag – Potassic fertilizers –MOP, SOP properties.
29. Secondary and micronutrient fertilizers – Different sources of these nutrients and their contents - Conditions leading to their deficiency - Methods of application and mode of action of NPK fertilizers in soils.
30. Amendments – Role of important organic and inorganic amendments and synthetic conditioners as amendments - Complex fertilizers – Types, composition of DAP, MAP, UAP, important nitrophosphates.
31. Mixed fertilizers – Advantages and disadvantages over straight fertilizers - Nano-fertilizers- Fertilizer grade – Fertilizer ratio – unit value of fertilizers – Problems - INM - Components - Advantages.
32. Fertilizer Control Order (FCO) – Its importance and regulations - Specifications for important fertilizers - Fertilizer storage – Specifications - Problems during storage.

### **Practicals**

- 1 Introduction to analytical instruments and principles-spectrometry and flame photometry
- 2 Estimation of available N in soils
- 3 Estimation of available P in soils
- 4 Estimation of available K in soils
- 5 Estimation of available S in soils
- 6 Estimation of available Ca and Mg in soils
- 7 Estimation of available Zn in soils
- 8 Basics of Plant analysis and estimation of N in plant samples
- 9 Estimation of P in plant samples
- 10 Estimation of K & S in plant samples
- 11 Identification acid radicals in fertilizers /salts
- 12 Identification of basic radicals in fertilizer /salt
- 13 Estimation of N in Ammonium sulphate
- 14 Estimation of N in Urea and FYM
- 15 Estimation of water soluble  $P_2O_5$  in SSP
- 16 Estimation of K in Muriate of potash or Sulphate of potash by using Flame photometer

## References

1. Indian Society of Soil Science.2012. *Fundamentals of Soil Science*. IARI, New Delhi.
2. Yawalkar K.S, Agarwal, T.P and Bokde, S 1995. *Manures and Fertilisers*. Agril. Publishing House, Nagpur
3. Samuel Tisdale, Nelson Werner L, Beaton James D and Havlin John L. 2005. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management*, Macmillian Publishing Co., New York.
4. D. K .Das 2014. *Introductory Soil Science*. Kalyani Publishers, New Delhi

**SSAC 321**

**PROBLEMATIC SOILS AND THEIR MANAGEMENT**

**2(1+1)**

### Course outlines

#### Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Their categorization based on properties. Reclamation and management of Saline and Sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils. Irrigation water – quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils. Bio remediation through multipurpose tree species of soils, land capability and classification, land suitability classification. Problematic soils under different Agroeco systems.

#### Practical

Field identification of problem soils. Determination of soil pH, EC, gypsum requirement of alkali soils, lime requirement of acid soils, calcium carbonate content in soils. Water quality assessment (pH, EC, alkalinity, chlorides, SAR, RSC).

### Lecture outlines

#### Theory

1. Problem soils –Definition – Different types of problematic soils – Extent and distribution of problematic and wastelands soils in different agro-eco systems and in Andhra Pradesh.
2. Salt affected soils – Origin and formation - Distribution of salt affected soils in India and Andhra Pradesh - sCharacteristic features of saline, sodic and saline – sodic soils – Diagnostic criteria based on properties.
3. 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.
4. Sodic soils - Visual symptoms for identification of sodic soils - Effect of sodicity on plant growth and nutrient availability - Reclamation and management.
5. 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.
6. Acid sulphate soils – Origin – Types – Characterization - Constraints and management.
  7. Land degradation - Eroded, compacted, flooded and water logged soils – Biologically sick soils – Effects on plant growth – Management.
  8. 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.
  9. Soil pollution - Potentially toxic elements - Excessive use of fertilizers, pesticides and weedicides – Heavy metal contamination – Management.
  10. Bio-remediation of problem soils through Multi Purpose Tree Species.
  11. Taxonomic classification of soils - Land Capability Classification.
  12. Land suitability classification - Index – Criteria - Different approaches – Land suitability for different crops.
  13. Remote Sensing and GIS techniques in diagnosis, mapping and management of degraded and problematic soils.
  14. Soil health and quality – Definition - Concepts – Soil resilience – Factors affecting soil quality (Physical, chemical and biological) – Assessment of soil quality - Management and improvement of soil quality.
  15. Irrigation water – Quality and standard parameters - Classification based on ICAR, CSSRI and USDA criteria.
  16. Guidelines for judging quality of water - Utilization of saline water in agriculture.

### **Practicals**

1. Field identification of problematic soils and visit to degraded lands.
2. Determination of infiltration rates of light soils.
3. Determination of infiltration rates of heavy soils.
4. Determination of aggregate stability of sodic soils.
5. Determination of pH, E<sub>c</sub> of acid, saline and sodic soils.
6. Determination of ESP of sodic soils.
7. Determination of GR of sodic soils.
8. Determination of LR of acid soils.
9. Determination of lime content (CaCO<sub>3</sub>) of calcareous soil.
10. Determination of pH and EC of saline, sodic and good quality irrigation water.
11. Determination of CO<sub>3</sub><sup>2-</sup> and HCO<sub>3</sub><sup>-</sup> in irrigation water.
12. Determination of chlorides in irrigation water.

13. Determination of Ca and Mg content in irrigation water.
14. Determination of Na and K content in irrigation water.
15. Computation of quality class, RSC and SAR of irrigation water.
16. Evaluation and interpretation of analytical data of problematic soils and suggesting ameliorating practices.

### **References**

1. Indian Society of Soil Science. 2012. *Fundamentals of Soil Science*, IARI, New Delhi.
2. Das, D. K. 2015. *Introductory Soil Science*. 4<sup>th</sup> Edition, Kalyani publishers, New Delhi
3. *Soils of Andhra Pradesh*, Monograph of I.V. Subbarao.

**Course outlines****Theory**

History of Entomology in India. Factors for insect's abundance. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, wing venation, modifications and wing coupling apparatus. Structure of male and female genital organs. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive systems in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes and chemoreceptors.

Systematics: Taxonomy—importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto orders, basic groups of present day insects with special emphasis to orders and families of agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Miridae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Lymantridae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Apionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyzidae, Culicidae, Muscidae and Tephritidae.

**Practical**

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems 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 and S. Pradhan; ML Roonwal, T.Kumara Swami, M R G K Nair,K.K. Nayar and N. Ananthakrishnan - Locations and year of establishment of Division of Entomology, IARI, Zoological Survey of India (ZSI), Directorate of Plant Protection, Quarantine and Storage (DPPQS), Indian Institute of Natural Resins and Gums (IINRG), 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).

- 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, Diplopoda and Onychophora;
- 4 Structure and functions of body wall and moulting – Different layers, chemical composition, 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 of insect head - Thorax – Segments and appendages (wings and legs).
- 6 Abdomen – Segments, pre and post genital appendages (Furcula, cornicles, tracheal gills and pseudo ovipositor 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 – 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 diapause – 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 Apodus with examples - Pupa- Obtect- Exarate- Coarctate- Chrysalis with examples.
- 13 Digestive system – Alimentary canal – Structure of foregut, midgut and hindgut – histology, functions, filter chamber and peritrophic membrane – Process 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 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.
- 19 Secretory (endocrine) system – Structure and functions of neurosecretory organs (neuro secretory cells of brain, corpora cardiaca, corpora allata, prothoracic glands and ring gland).
- 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 – Binomial nomenclature - Holotype, allotype and paratype – Suffixes of tribes, subfamily, 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 upto Orders – Subclasses - Apterygota and Pterygota– Names of Orders of Apterygota and Pterygota with examples - Orthopteroid, Hemipteroid and Panarpooid group of orders.
- 22 Orthoptera – General characters - Gryllidae, Acrididae, Tettigonidae 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 - Order – Thysanoptera – General characters –Thripidae –Characters with examples
- 25 Hemiptera – General characters - Sub order Heteroptera – Characters - Cimicidae - Miridae, Pentatomidae, Lygaeidae, Coreidae, Pyrrhocoridae - Characters with examples.

- 26 Hemiptera - Suborder Homoptera – Characters – Delphacidae, Cicadellidae, Aleurodidae, Aphididae, Coccidae, Pseudococcidae, Lopophidae- Characters with examples -Neuroptera – General characters - Chrysopidae- characters with examples.
- 27 Lepidoptera-General characters - Differences between moths and butterflies - Noctuidae, Lymantriidae and Sphingidae and Pieridae- Characters with examples.
- 28 Lepidoptera- General characters - Pyralidae, Crambidae, Gelechiidae, Lycaenidae, Arctiidae, Papilionidae, Saturniidae and Bombycidae - Characters with examples.
- 29 Coleoptera - General characters – Scarabaeidae, Coccinellidae, Chrysomelidae, - Characters with examples.
- 30 Coleoptera - General characters – Cerambycidae, Bruchidae, Apionidae and Curculionidae - Characters with examples.
- 31 Hymenoptera - General characters – Tenthredinidae, Ichneumonidae, Braconidae, Chalcididae, Trichogrammatidae, and Apidae- Characters with examples.
- 32 Diptera -General characters - Culicidae, Cecidomyiidae, Muscidae, Tachinidae, Agromyzidae and Tephritidae - Characters with examples.

### **Practical**

- 1 Methods of collection and preservation of insects including immature stages.
- 2 External features of Grasshopper / Blister beetle.
- 3 Study of types of mouthparts – Biting and chewing, piercing and sucking, rasping and sucking, chewing and lapping, sponging and siphoning.
- 4 Study of different types of insect antennae and legs.
- 5 Study of wing venation, types of wings and wing coupling mechanisms.
- 6 Study of different types of insect larva and pupa.
- 7 Dissection of digestive system in insects (Grasshopper).
- 8 Dissection of female and male reproductive systems in insects (Grasshopper).
- 9 Study of characters of Orders - Orthoptera, Dictyoptera and their families and Odonata.
- 10 Study of characters of Orders - Isoptera and Thysanoptera and their families.
- 11 Study of characters of Orders -Hemiptera and its sub order Heteroptera and their 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.

### **References**

1. Chapman, R. F. 2013 *Insects: Structure and Function*. Ed by Simpson, S. J. and Douglas, A. C. Cambridge Univ. Press, UK.
2. Richards, O.W. and Davies, R.G. 1977. *Imm's General Text Book of Entomology* (Vol. I and II). Chapman and Hall, London.
3. Wigglesworth, V.B. 2013. *Insect Physiology*. Springer (Originally published by Chapman and Hall, London, 1974).
4. Pant, N.C. and Ghai, S. 198. *Insect Physiology and Anatomy*. ICAR, New Delhi.
5. Kapoor, V. C. 2008. *Theory and Practice of Animal Taxonomy*. Oxford and IBH Publishing, New Delhi.
6. Charles A Triplehom and Norman F. 2005. *Borrer and De Long's Introduction to the Study of Insects*. Johnson Thomson Brooks/Cole Publishing. U.S.A.
7. Snodgrass, R.E. 2001. *Principles of Insect Morphology*. CBS Publishers & Distributors, Delhi.
8. Timbhare, D.B. 2015. *Modern Entomology*, Himalaya Publishing House.

**ENTO 231**

**FUNDAMENTALS OF ENTOMOLOGY II  
(INSECT ECOLOGY & CONCEPTS OF IPM)**

**2(1+1)**

**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 parasites, predators, transgenic plants, pathogens such as bacteria, fungi, EPNs and viruses). Methods of control: Chemical control-importance, hazards and limitations. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Insecticides Act 1968-Important provisions. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Beneficial insects: Important species of pollinators, weed killers and scavengers and their importance.

**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 – Acquaintance of mass multiplication techniques of important predators :Cheilomenes, Chrysoperla and Cryptolaemus.Important parasitoids: Egg, larval and pupal parasitoids viz., Trichogramma, Apanteles and Tetrastichus.Important Entomopathogenic Fungi: Beauveria bassiana and Nucleo Polyhedro 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 mammals. House hold 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 behavior. 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, stage of host, duration 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 pests with examples.
- 9 Mechanical control- Different mechanical methods of pest control with examples.
- 10 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.
- 11 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.
- 12 Microbial control - Important groups of micro organisms - Bacteria, viruses and fungi used in pest control and their mass multiplication techniques - Transgenic plant pathogens – Bacteria, fungi and viruses - Entomopathogenic nematodes – Important species - Mode of infectivity and examples.
- 13 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 Knockdown Dose) and KT50 (Median Knock Down Time) – Bioassay methods.
- 14 Formulations of insecticides - Dusts, granules, wettable powders, water dispersible granules, solutions, emulsifiable concentrates, suspension concentrates, concentrated insecticide liquids, fumigants, aerosols, gels, micro encapsulations, tablets, baits and mixtures of active ingredients – Advantages and disadvantages of chemical control
- 15 Recent methods of pest control - Repellents (physical and chemical), Antifeedants - importance of antifeedants and limitations of their use – Attractants - Sex pheromones - List of 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 - Compatibility of pesticides - Phytotoxic effects of insecticides - Safe use of pesticides - Symptoms of poisoning - First aid and antidotes for important groups of insecticides. Insecticide Act 1968-Important provisions - Insecticide resistance,

resurgence and residues - Maximum Residue Limits (MRL) – Acceptable Daily Intake (ADI) – Safe waiting periods.

### Practical

- 1 Sampling techniques for the estimation of insect population in different crops
- 2 Study of distribution patterns of insects in crop ecosystems
- 3 Techniques for the estimation of insect damage in different crops
- 4 Pest surveillance through light traps, pheromone traps and forecasting of pest incidence
- 5 Acquaintance of insecticide formulations
- 6 Calculation of doses/ concentrations of different insecticidal formulations
- 7 Compatibility of pesticides with other agrochemicals and phytotoxicity of insecticides
- 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 *Tetrastichus* sp. (Pupal) parasitoids
- 11 Acquaintance of mass multiplication techniques of the Entomopathogenic fungus, *Beauveria bassiana*
- 12 Acquaintance of mass multiplication techniques of Ha NPV and SI 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 house hold and veterinary insect pests.

### References

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**ENTO 331**

**PESTS OF FIELD CROPS, STORED GRAINS  
AND THEIR MANAGEMENT**

**3(2+1)**

**Course outlines**

**Theory**

General account 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 pests and scientific name, order, family, host range, distribution, nature of damage and control practices for other important arthropod pests of various field crops. Mites, birds, nematodes and rodent pests of field crops and their management. Locust management. Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structures and methods of grain storage and fundamental principles of grain store management.

**Practical**

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking different crops and their produce: (a) Field Crops; Identification of mites, birds and rodent pests of crops. Identification of insect pests and Mites associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides. Pesticide application techniques. Fumigation of grain store / godown. Identification of rodents and rodent control operations in godowns. Identification of birds and bird control operations in godowns. Determination of moisture content of grain. Methods of grain sampling under storage condition. Visit to Indian Storage, Management and Research Institute, Hapur and Quality Laboratory, Department of Food., Delhi. Visit to nearest FCI/CWC godowns.

**Lecture outlines**

**Theory**

General account on nature and type of damage by different arthropod pests. Scientific name, order, family, host range, distribution, marks of identification, bionomics, nature of damage, and management of major, minor insect pests and other important arthropod pests of various field crops.

- 1 Introduction of Economic Entomology and Economic Classification of Insect Pests
- 2 - 5 Rice-Yellow stem borer and other borers, gall midge, brown - planthopper, green leafhopper, hispa, leaf folder, ear head bug, grasshoppers, root weevil, swarming

- caterpillar, climbing cutworm, case worm, whorl maggot, leaf mite and panicle mite-IPM practices.
- 6-8 Sorghum and other millets- Sorghum shoot fly, stem borer, pink borer, sorghum midge, ear head bug, red hairy caterpillar, deccan wingless grasshopper, aphids, maize shoot bug, flea beetle, blister beetles, ragi cutworm, ragi root aphid and army worm- IPM practices.
- Wheat- Ghujia weevil, ragi pink borer and termites- IPM practices.
- 9-11 Sugarcane- Early shoot borer, internode borer, top shoot borer, scales, leafhoppers, white grub, mealybugs, termites, whiteflies, woolly aphid and yellow mite- IPM Practices.
- 12-14 Cotton- Spotted bollworm, American bollworm, pink bollworm, tobacco caterpillar, leafhopper, whiteflies, aphid, mites, thrips, red cotton bug, dusky cotton bug, leaf roller, stem weevil, grasshoppers, and mealybug - IPM Practices.
- 15-16 Jute- Semilooper, stem weevil, stem girdler and Bihar hairy caterpillar. Mesta- Hairy caterpillars, stem weevil, mealybugs, leafhopper and aphid. Sunhemp- Hairy caterpillars, stem borer and flea beetle. IPM Practices.
- 17-18 Pulses- Gram caterpillar, plume moth, pod fly, stem fly, spotted pod borer, cowpea aphid, cowbug, pod bug, leafhopper, stink bug, green pod boring caterpillar, blue butterflies, leaf webber/borer and redgram mite. Soyabean- Stem fly, stem girdler, ragi cutworm, leaf miner and whitefly- IPM Practices. Pea- pea leaf miner and pea stem fly
- 19 Castor-Semilooper, shoot and capsule borer, tobacco caterpillar, leafhopper, butterfly, whitefly, thrips, castor slug and mite- IPM Practices.
- 20 Groundnut - White grub, leaf miner, red hairy caterpillar, tobacco caterpillar, leafhopper, thrips, aphid, pod bug, bud borer, wire worms and jewel beetle- IPM Practices.
- 21 Sesamum-Leaf and pod borer, gall fly and sphinx caterpillar. Safflower- Aphids and leaf eating caterpillars- IPM Practices.
- 22 Mustard- Aphid, sawfly, diamondback moth and painted bug.  
Sunflower- Helicoverpa and Spodoptera, leafhopper, Bihar hairy caterpillar and thrips - IPM Practices.
- 23 Stored grains Pests- Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain
- 24-25 Stored grain Insect pests - Rice weevil, lesser grain borer, khapra beetle, pulse beetle, groundnut bruchid, flour beetles, saw-toothed beetle, cigarette beetle, angoumois grain moth and rice moth
- 26-27 Stored grains - Non insect Pests- Mites, rodents, birds and microorganisms associated with stored grain - Storage structures and methods of grain storage and fundamental principles of grain store management.

- 28 Locusts- Locusts and their management
- 29 Mites- Economically important phytophagous mites of field crops and their management
- 30 Nematodes-White tip nematode of rice, cyst and gall nematode of wheat, and their management.
- 31 Rodents- Rodents damaging field crops and stored grains - Keys for identification of rodents and their management.
- 32 Birds- Various birds infesting crops and their management.

\*Important insects and their scientific names may only be chosen for examination purpose.

### **Practical**

- 1 Typical symptoms of damage by various phytophagous insects.
- 2 Calculations on the doses of insecticides and their application techniques.
- 3 Identification of major insect pests of rice and their damage symptoms
- 4 Identification of major insect and mite pests of sorghum, maize and other millets, and their damage symptoms
- 5 Identification of insect pests of sugarcane and their damage symptoms
- 6 Identification of insect pests of cotton, sunhemp and mesta and their damage symptoms
7. Identification of insect pests of pulse crop and their damage symptoms. Identification of insect pests of oil seed crops and their damage symptoms
- 8 Mite pests of crops and their damage symptoms
- 9 Nematode pests of crops and their damage symptoms
- 10 Rodent pests of crops and their nature of damage
- 11 Bird pests of crops and their damage symptoms
- 12 Identification of insect and non insect pests (mites, birds and rodents) of stored grain, their nature of damage and their management tactics..
- 13 Methods of grain sampling under storage condition. Determination of moisture content of grain
- 14 Methods of detection of infestation by stored grains insect pests in stored grain
- 15 Assessment of losses in stored grain due to insect pests.
- 16 Fumigation of grain store / godown. Visit to nearest FCI/CWC/SWC godowns.

### **References**

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**ENTO 332**

**PESTS OF HORTICULTURAL CROPS AND  
THEIR MANAGEMENT & BENEFICIAL INSECTS**

**3(2+1)**

**Course outlines**

**Theory**

General account 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 pests and scientific names, order, family, host range, distribution, nature of damage and control practices for other important arthropod pests of various vegetable crops, fruit crops, plantation crops, ornamental crops, narcotics, spices and condiments.

Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties, methods of harvesting and preservation of leaves. Rearing of mulberry silkworm, rearing appliances, mounting and harvesting of cocoons. Pests and diseases of silkworm, management, and methods of disinfection.

Importance of beneficial insects, bee keeping, pollinating plants and their cycle, bee biology, commercial methods of rearing, equipment used and seasonal management. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee.

Species of lac insect, morphology, biology, host plant and lac production – Processing of lac - seed lac, button lac, shellac and lac- products.

Identification of major parasitoids and predators commonly used in biological control. Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers and their importance.

## Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking horticultural crops - vegetable crops, fruit crops, plantation gardens, narcotics, spices & condiments. Visit to orchards and gardens.

Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Types of silkworm, voltinism and biology and rearing of silkworm and equipment. Honey bee species and castes of bees. Beekeeping appliances and seasonal management. Bee enemies and diseases. Bee pasturage, bee foraging and communication. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to sericulture, beekeeping, lac culture and natural enemies.

## Lecture outlines

### Theory

General account on nature and type of damage by different arthropod pests. Scientific name, order, family, host range, distribution, marks of identification, bionomics, nature of damage, and management of major, minor insect pests and other important arthropod pests of various vegetable crops, fruit crops, plantation crops, ornamental crops, narcotics, spices and condiments.

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

- 11 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.
- 12 Banana- Rhizome weevil, skipper, aphid and pseudostem weevil - Papaya- whiteflies, mealybugs and thrips - Apple - Woolly aphid and Codling moth - Custard apple- Mealybug - IPM practices
- 13 Coconut- Black headed caterpillar, rhinoceros beetle, red palm weevil, slug, termites, scale and mite - Oil palm- Black headed caterpillar, rhinoceros beetle and red palm weevil - IPM practices.
- 14 Arecanut- Scales - Cocoa - Scales - Cardamom- Thrips - Pepper- Pollu beetle and shoot borer - Eucalyptus - Gall wasp - Neem - Tea mosquito bug and white grub - IPM practices.
- 15 Turmeric and ginger- Rhizome fly and Lace wing bug - Betelvine- Shoot bug and tobacco caterpillar - Onion- Thrips and *Spodoptera exigua* - Coriander- Aphids and leaf eating caterpillar - 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 and green scale; Tea- Tea mosquito bug, thrips, red spider mite, pink mite, purple mite and scarlet mite- IPM practices.
- 16 Economically important mite, nematode (vegetables, citrus, banana and coconut), rodent (coconut) and bird pests of horticultural crops and their management.
- 17 Beneficial insects – Importance of silkworm, honeybee, lac insects, predators, parasitoids, pollinators, weed killers and scavengers.
- 18 Species of Silkworms - Characteristic features of Mulberry Silkworm, Tasar Silkworm, Eri Silkworm and Muga Silkworm and their hosts- Biology – Voltinism - Ahimsa silk.
- 19 Establishment of mulberry garden – Planting season and land preparation, preparation of planting material - Irrigation- spacing, varieties, planting inter cultivation, fertilization, irrigation, leaf harvest and leaf yield - Mulberry Planting under rainfed and irrigated conditions - Spacing and preparation of pits, planting, fertilization, inter-cultivation, maintenance, soil moisture conservation and leaf harvest - Pests and diseases of mulberry plants and their management - Rearing house, rearing equipment and appliances-rearing stand, chawki rearing trays, late age rearing trays, paraffin wax coated paper, bird feathers, bed cleaning nets, chop sticks, rubber foam, ant well, mountages, chopping knife, chopping board, feeding basins, disinfection and hygiene in rearing house.
- 20 Mulberry silkworm races - Grainage centres, brushing of silkworm larvae, young age and late age silkworm rearing - Effect of temperature, humidity, air current and photoperiod - Leaf quality and leaf maturity on larval growth and survival - Feeding of late instars, bed cleaning and bed spacing for IV and V instars
- 21 Mounting- mountages, mounting density, harvesting and assessment of cocoon yield and cocoon characters for marketing - Defective cocoons.

- 22 Silk worm diseases- Pebrine- Symptoms, mode of transmission, stages of contamination and intensity, detection and control -Viral diseases- Nucleo polyhedro Virus and Cytoplasmic Polyhedro Virus - Symptoms, prevention and control. Grasserie - Symptoms, source of contamination, prevention and control - Infectious Flacherie - Symptoms, prevention and control - Fungal Diseases- White muscardine- Source of infection, symptoms, prevention and control - Uzi fly – Biology, nature of damage and symptoms and management.
- 23 Beekeeping- Importance and multiple source of income - Species of Honey bees-Rock bee, Little bee, Indian honey bee, European bee and Dammar bee - Bee biology- Life cycle - Caste determination in honey bees- Structural adaptations of honeybees.
- 24 Commercial methods of rearing, – Different types of the hive- Equipment - Smoker, bee veil, gloves, honey extractor, queen gate, queen excluder sheet, drone extruder, drone trap, comb foundation sheet, dummy division board, swarm trap, bee brush, feeder, queen cage and queen cell protector - Colony management in different seasons, winter, summer and rainy seasons.
- 25 Bee pasturage – Different species of pollen and nectar yielding plants- Honey flow season and dearth period – Communication in bees – Round dance and wag tail dance- Management of bees for crop pollination – Queen bee substance -Honey extraction, testing of honey, honey composition and value, bee wax, pollen, royal jelly, propolis, venom and its uses.
- 26 Enemies of bees and bee brood - Nature of damage and management of Greater wax moth, lesser wax moth, wax beetle, wasps, black ants, birds *etc.*, - Nature of damage and management of honey bee - *mites, Acarapis woodi, Varroa jacobsoni* and *Tropilaelaps clareae*.
- 27 Bee diseases – Nature of damage and management of American foul brood disease, European foul brood disease, Sac brood disease, Thai sac brood disease, Chalk brood, stone brood disease, Nosema and Amoeba disease - Colony collapse disorder in bees.
- 28 Lac insect- Different species, morphology, behaviour, host plants, inoculation methods, natural enemies of lac insect and their management - Lac production – Processing, different forms of lac- raw lac, seed lac, shellac and lac by - products. Recent applications of lac.
- 29 Identification of biological control agents - Insect predators and parasitoids, pathogens, entomopathogenic nematodes.
- 30 Insect orders bearing predators and parasitoids used in pest control and their key identification characters (Dictyoptera: Mantidae; Hemiptera: Reduviidae, Anthocoridae, Lygaeidae, Pentatomidae; Neuroptera: Chrysopidae, Myrmeleontidae, Hemerobiidae; Coleoptera: Carabidae, Cicindelidae, Coccinellidae; Diptera: Asilidae, Tachinidae, Syrphidae; Lepidoptera: Noctuidae, Lycaenidae, Epipyropidae, Pyralidae; Hymenoptera: Vespidae, Braconidae, Ichneumonidae, Chalcididae, Trichogrammatidae, Platygasteridae, Elasmidae, Eulophidae, Scelionidae and Strepsiptera).

- 31 Mass production/multiplication methods of predators (Cheilomenes and Chrysoperla) parasitoids (Goniozus nephantidis).
- 32 Important species of pollinators, weed killers, and scavengers and their significance.

### **Practical**

- 1 Identification of insect pests of Solanaceous and Malvaceous vegetables and their damage symptoms
- 2 Identification of insect pests of Cruciferous and Cucurbitaceous vegetables and their damage symptoms
- 3 Identification of insect pests of leafy vegetables, potato, sweet potato, moringa and chilli and their damage symptoms (Potato and Chillies are Solanaceous crops).
- 4 Identification of insect pests of mango, cashew, citrus & banana and their damage symptoms.
- 5 Identification of insect pests of grapevine, pomegranate, sapota, papaya, apple, custard apple, ber and guava and their damage symptoms.
- 6 Identification of insect pests of coconut, arecanut, cocoa, cardamom, pepper, date palm & oil palm, eucalyptus and neem and their damage symptoms.
- 7 Identification of insect pests of spices, narcotics (turmeric, betel vine, onion, tobacco & ginger) and ornamental plants (jasmine, rose, chrysanthemum) and their damage symptoms.
- 8 Identification of economically important mite, nematode (vegetables, citrus, banana and coconut), rodent (coconut) and bird pests of horticultural crops and their management.
- 9 Acquaintance with silkworm species and small scale rearing of mulberry silkworm.
- 10 Acquaintance with different appliances of silkworm rearing, model rearing house and methods of disinfection.
- 11 Acquaintance with handling of chawki and late age silkworm rearing - Feed change and spacing techniques.
- 12 Dissection of silkworm larval mouthparts and salivary glands.
- 13 Acquaintance with important species of honey bees, caste system, structural adaptations, beekeeping appliances and different beehives.
- 14 Seasonal management of honey bees and their enemies and diseases.
- 15 Visit to nearby silkworm rearing and bee keeping centres.
- 16 Identification of various lac products.

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6. Singh, S.1975. *Bee Keeping in India - Indian Council of Agriculture research*, New Delhi.
7. Mishra, R.C. 1995. *Honey Bees and Their Management in India* – Indian Council of Agricultural Research, New Delhi.
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**Course outlines****Theory**

**Economics:** Economic activity and economy-Economics- Meaning, scope and subject matter, definitions, Approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory-rationality assumption, economic laws as generalization of human behavior. Basic concepts: scarcity, choice and decision making Goods and services, wants, demand, utility, cost and price, wealth, capital, income, investment, welfare, efficiency ,equilibrium, and firm.

**Demand:** meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, Equi-marginal utility principle. Indifference curve analysis, 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:** Production process, creation of utility, factors of production, input - output relationship. Laws of returns. **Cost:** Production costs, **Supply:** meaning, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply and its measurement

**Market structure:** meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; equilibrium price. Market dynamics- changes in demand and supply and prices.

**Distribution theory:** meaning, factor market and pricing of factors of production. Concepts of rent, wage interest and profit.

**Public Finance/Public policy:** meaning importance, Public revenue and public expenditure and their importance. Sources of public revenue, **Taxes:** meaning, direct and indirect taxes, agricultural taxation, VAT and GST.

**National income:** Meaning and importance, circular flow in the economy, concepts of national income accounting and approaches to measurement, difficulties in measurement. Trends in contribution of different sectors' to GDP .Indian economy in the globalised economy.

**Population:** Economic importance, Malthusian population theory, technological transition and economic growth, natural and socio-economic determinants, demographic transition in India, population growth,

**Money, Banking and Credit:** Evolution, meaning and functions of money, classification of money, flows of money in the economy, money supply, general price index, inflation and deflation. **Banking:** Role in modern economy, borrowing and lending, functions of commercial and central bank, credit ; meaning , role of credit in modern economy ,credit policy.

**Economic systems:** Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

## Lecture outlines

### Theory

1. Introduction to Economics– Economic activity and concept of economy and its functions, basic economic problems, three main economic actors-households, firms, governments as basic decision making units.
2. Economics - Meaning, definitions, its importance as a subject to science students.
3. Scope of study of economics as a science -Subject matter of economics – Traditional approach – Consumption, production, exchange, distribution and public finance/ public policy - Modern Approach – Microeconomics and macroeconomics.
4. Methods of economic investigation – Deduction and induction approaches, positive and normative analysis - Nature of economic theory - Rationality assumption, economic laws as generalization of human behavior.
5. Basic concepts: goods and services - Characteristics and classification, scarcity, choice, decision making, wants, substitutes and complements - Utility – Cardinal and ordinal approaches, forms of utility, marginal utility.
6. Cost and price, value and wealth and their characteristics, capital, income, investment, welfare, efficiency, equilibrium and firm.
7. Demand - Meaning, law of demand, demand schedule and demand curve characteristics, determinants, types of demand - Income demand, price demand, cross demand - Product demand, firm demand, market demand.
8. Market dynamics due to changes/ shifts in demand and prices - Contraction and extension, increase and decrease in demand.
9. Law of diminishing marginal utility – Statement, assumptions of law, explanation, limitations of the law - Importance and applications.
10. Law of equi-marginal utility – Meaning, assumptions, explanation of the law - Practical importance and applications, limitations.
11. Consumer's surplus – Meaning, assumptions, explanation with examples, difficulties in measuring, consumer's surplus - Importance and applications - Engels law of family expenditure.
12. Indifference curve analysis - Indifference curves - Meaning, basic assumptions, properties and their importance in economics.
13. Budget line and its properties - Consumer's equilibrium - Graphical and algebraic expressions and its importance.
14. Elasticity of demand – Meaning, elastic and inelastic demand, measurement of elasticity of demand - Types of elasticity of demand - Price elasticity, income elasticity and cross elasticity of demand.
15. Kinds of elasticity of demand - Perfectly elastic, perfectly inelastic, relatively elastic, relatively inelastic, unitary elastic demand - Factors affecting elasticity of demand, practical importance of elasticity of demand.

16. Production - Meaning of production process, creation of utility, factors of production and input - output relationship and production function – Meaning.
17. Laws of returns - Increasing, decreasing and constant laws of returns - Meaning and explanation with examples.
18. Cost - Seven production costs - Meaning and formulas, cost and output relationships - Short run and long run cost curves.
19. Supply – Meaning, definition, law of supply, supply schedule, supply curve and properties, determinants of supply - Market dynamics due to changes/ shifts in supply and prices - Increase and decrease in supply, contraction and extension of supply.
20. Elasticity of supply and its measurement - Kinds of elasticity of supply – Perfectly elastic, perfectly inelastic, relatively elastic, relatively inelastic and unitary elastic - Factors affecting elasticity of supply.
21. Markets and market structure – Meaning, classification of markets based on market structure - Competition and its meaning, basic features of perfectly competitive and imperfect competitive markets.
- 22&23. Characteristics of monopolistic competition, monopoly, duopoly, oligopoly, monopsony, duopsony and oligopsony with examples.
24. Price determination under perfect competition – Equilibrium analysis - Numerical and graphical explanation.
25. Distribution theory - Meaning, factor market - Concepts of rent - Meaning, types of rent - Ricardian theory of rent.
26. Wages - Meaning, nominal and real wages, working population in India - Labour participation rate, employment rate, unemployment rate - Interest- Meaning of interest and interest rate - Profit and income - Meaning, difference between income and profit.
27. Pricing of factors of production - Modern theory of distribution.
28. Public finance/ Public policy – Meaning, role and importance of public finance/Public policy - Functions of the government – Differences between public finance and private finance - Public revenue - Meaning, major and minor sources of public revenue.
29. Tax – Meaning - Classification – Direct and indirect taxes, methods of taxation - Proportional, progressive, regressive and digressive taxation, agricultural taxation - VAT and GST.
30. Canons of taxation – Adam Smith’s canons of taxation – Equality, economy, certainty and convenience – Other canons of taxation.
31. Public expenditure – Meaning, need for public expenditure - Principles of public expenditure – Budget – Meaning - Balanced budget and deficit budget - Fiscal policy - Meaning and its policy instruments.

32. National income accounting system – Meaning and importance, circular flow in the economy.
33. Concepts of national income accounting - Gross domestic product, gross national product, net national product, net domestic product- National income at factor cost, personal income, disposable income, per capita income.
34. Approaches to measurement of national income – Product method, income method, expenditure method and value added method, difficulties in measurement.
35. Trends in contribution of different sectors' to GDP - Indian economy in the globalised world economy.
36. Importance of population in the economy - Malthusian theory, escaping from the Malthusian stagnation - Innovations, technological transition and economic growth.
37. Money - Meaning, evolution of money, functions of money, the money market - Types of demand and supply of money in the economy.
38. Credit - Meaning of credit, borrowing and lending, investments and their role in the modern economy - Credit controls and credit policy.
39. Role of banking in the modern economy, functions of central bank and commercial banks, monetary policy and its instruments.
40. Inflation – Meaning, definition, deflation - Meaning, causes of inflation - Demand pull and cost push inflation.
41. Types of inflation - Comprehensive and sporadic inflation – Suppressed and repressed inflation – Creeping, walking, running and galloping inflation – Mark up inflation.
42. General price index, wholesale price index, consumer price index - Rate of inflation – Measurement.
43. Other causes of inflation – Remedial measures – Monetary and fiscal measures.
44. Economic system - Meaning, importance of study of economy in systems approach - Types of economic systems.
45. Capitalism- Meaning and its characteristic features, socialism and its characteristic features - Mixed economies and their characteristic features.
46. Economic planning - Meaning, importance of planning in management of resources and institutions in the economy, elements of economic planning.
- 47 & 48. Brief history of planning system in India - Annual plans, five year plans meaning and objectives, role of planning commission of India and NITI Ayog.

## Reference

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3. Paul A. Samuelson and Nordhus. 2010. *Economics*. 19<sup>th</sup> Edition, Tata-Mc Graw Hill Education, New Delhi.
4. Jhingan, M.L.1990. *Advanced Economic Theory*. Vikas Publishing House, New Delhi
5. Koutsoyiannis. 2015. *Modern Microeconomics*. Tata Mac-Graw Hill Publishers, New Delhi
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**AECO 241**

**AGRICULTURAL FINANCE AND CO-OPERATION**

**2(1+1)**

### **Course outlines**

#### **Theory**

Agricultural Finance- meaning, scope and significance, capital and credit needs and their role in Indian agriculture. credit: meaning, definition, need, classification. Credit analysis: 3 R's, and 5C's and 7 Ps of credit analysis. Sources of agricultural finance: institutional and non-institutional sources, social control and nationalization of commercial banks, RRBs, Lead bank scheme,. Crop loan scheme,Scale of finance and unit cost. Cost of credit, KCC. Financial inclusion, Micro financing, and schemes for financing weaker sections. Crop insurance, AICI, PMFBY.

Introduction to higher financing institutions– RBI, NABARD, World bank group institutions. Recent developments in agricultural credit. Agril. Projects – project- meaning, importance, Project cycle and phases., Basic guidelines for preparation of project reports.

Agricultural Cooperation – Meaning, objectives, principles of cooperation, brief history of cooperative development in India, , significance of cooperatives in Indian agriculture. Agricultural Cooperative institutions in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, , cooperative warehousing; Role of ICA, NCUI, NCDC.

#### **Practical**

Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprises. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures of lending and sanction of loans .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 value added products. Seminar on selected topics.

## Lecture outlines

### Theory

1. Agricultural Finance - Meaning, definition, nature and scope - Significance - Micro and macro finance - Capital and credit problems, need and their importance in Agriculture.
2. Credit - Meaning and definition - Classification of credit based on different criteria with examples.
3. Credit analysis - Economic feasibility tests - 3 R's of credit analysis - Returns to investment - Repayment capacity - Meaning, causes of poor repayment capacity of farmers, suggestions to improve repayment capacity - Risk bearing ability - Meaning, sources of risk, means to strengthen RBA.
4. Five Cs of credit – Character – Capacity – Capital - Condition and Commonsense - Seven Ps of credit - Principle of Productive purpose - Principle of personality - Principle of productivity - Principle of phased disbursement - Principle of proper utilization - Principle of payment and Principle of protection.
5. Social control and nationalisation - Meaning, objectives and their importance - Privatisation of commercial banks - Need and importance for institutional sources and structure of agricultural lending from different sources.
6. Lead bank scheme - Origin, objectives, functions - District credit plan - Regional Rural Banks (RRBs) - Origin, objectives, functions — RRBs in Andhra Pradesh.
7. Crop loan system - Objectives, importance, features of crop loan system - Scale of finance - Meaning and estimation and role of district level consultative committee - Term loans – Objectives and meaning of unit costs, fixation of unit costs and NABARD guidelines.
8. Financial inclusion - Meaning and importance - Micro finance - Meaning, importance, agencies providing microcredit banks, NBFs, NGOs, and Govt. agencies - SHGs and their role in microfinance and bank linkages - Micro finance lending and control act in Andhra Pradesh - Objectives and important features.
9. Schemes for financing weaker sections - Differential interest rate (DIR) - Integrated rural development programme (IRD) - Swarnajayanti gram swarozgar yojana (SGSY) - Self help groups (SHGs) etc., Srinidhi, MUDRA.
10. Higher financing agencies - Reserve Bank of India (RBI) - Objectives and functions and role in agricultural development and finance. National Bank for Agricultural and Rural Development (NABARD) - Origin, functions, activities and role in agricultural development.
11. World Bank (WB) - Objectives and functions -World Bank group institutions - role and functions of International Bank for Reconstruction and Development (IBRD) - International Development Agency (IDA) - International Finance Corporation (IFC), MIGA, ISID.
12. Crop insurance - Meaning and its advantages and limitations in application -

Agricultural insurance company of India - Objectives and functions - Indemnity - Meaning, premiums and claims - Prime Minister's Fasal Bhima Yojana (PMFBY) - Salient features - Weather based crop insurance - Salient features and its importance.

13. Agricultural project - Meaning, characteristics of agril. projects, project cycle and explanation of different phases of project cycle - Basic guidelines for preparation of project reports.
14. Co-operation - Meaning, Scope, importance and definition - Principles - Objectives of co-operation, significance of cooperatives in Indian agriculture.
15. Brief history of cooperative movement development in India - Recent developments in Indian cooperative movement - Short comings of Indian co-operative movement and remedies.
16. Agricultural Cooperative institutions in India - co-operative credit structure in India and Andhra Pradesh – Objectives and functions of state level (APCOB), district level (DCCB) and Village level (PACS) cooperative societies - Functions of marketing, consumer societies, multi-purpose cooperatives, farmers' service cooperative societies, dairy cooperatives - Andhra Pradesh mutually aided Co-operative Societies Act (1995) - Role of International Cooperative Alliance (ICA), National cooperative Union of India (NCUI), National Cooperative Development Council (NCDC).

### **Practical**

1. Estimation of credit requirement of farm business – A case study.
2. Estimation of scale of finance - Unit costs and KCC.
3. Determination of most profitable level of capital use.
4. Analysis of progress and performance of priority sector lending by commercial banks, Cooperatives, RRBs and non-institutional sources using published data. Working out different repayment plans with examples.
5. Lump sum repayment /straight-end repayment - Variable or quasi variable repayment.
6. Amortized decreasing repayment plan and amortized even repayment plan.
7. Estimation of indemnity for crop insurance claims.
8. Visit and study of a commercial bank to acquire firsthand knowledge of their management, schemes and procedures of lending and sanction of loans.
9. Visit and study of a cooperative bank - PACS/ DCCB to acquire firsthand knowledge of their management, schemes and procedures of lending and sanction of loans.
10. Visit and study of a cooperative society - dairy/ consumers to acquire firsthand knowledge of their management, schemes and activities.
11. Preparation and analysis of balance sheet – A case study.
12. Preparation and analysis of income statement – A case study.
13. Appraisal of a loan proposal – A case study.

14 -16. Techno-economic parameters for preparation of projects - Preparation of bankable projects for various agricultural products and value added products.

## References

1. Johil S.S. and C.V. Moore. 1970. *Essentials of Farm Financial Management*. Today and Tomorrow Printers and Publishers, New Delhi.
2. John, J. Hamptron.1983. *Financial Decision Making: Concepts, Problems and Cases, of India*. New Delhi.
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**AECO 242                      AGRICULTURAL MARKETING, TRADE AND PRICES                      3 (2+1)**

## Course outlines

### Theory

Agricultural Marketing: concepts and definitions of market, marketing, agricultural marketing, market structure, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities.

Marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transportation and processing; facilitating functions – packaging, branding, grading, quality control and labeling, AGMARK; Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing and their meaning.

Marketing channel-definition and meaning, marketing channels for different farm products and farm inputs.

Marketing mix and Market segmentation. Product life cycle (PLC) and competitive strategies: Meaning and stages in PLC, characteristics of PLC, strategies in different stages of PLC, pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits;

Market 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. agencies in agricultural marketing: Public sector institutions- CWC, SWC, FCI, & DMI – their objectives and functions; cooperative marketing in India- NAFED, MARKFED.

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

Risk in marketing: Types of risk in marketing; speculation & hedging; An overview of futures trading in agricultural commodities and role of commodity exchanges. Role of regulatory bodies in futures markets- SEBI, etc

Trade: Concept of International Trade and its importance in globalised world economies, theories of absolute and comparative advantage. Present status and prospects of Indian agri-commodities trade in international trade. WTO: its genesis, objectives, functions and principles of multilateral trade, WTO agreements- Agreement on Agriculture (AoA) and its implications on Indian agriculture; TRIPS and Intellectual property rights and their implications to Indian agriculture.

## **Practical**

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – SWC, CWC, FCI, cooperative marketing society —DCMS, etc. to study their objectives, role, organization and functioning; Application of principles of comparative advantage of international trade. Seminar on selected topics

## **Lecture outlines**

### **Theory**

1. Agricultural Marketing - Concepts and definitions of market, marketing, agricultural marketing - Components of market, dynamics of market structure.

2. Classification and characteristics of each type of agricultural markets.
3. Demand and supply of agri-commodities, factors affecting the demand and supply of farm products, producers surplus - Meaning and types and producer's surplus of agri-commodities in India.
4. Meaning of marketable surplus and marketed surplus, importance and their measurement. marketable surplus and marketed surplus of agri-commodities in india, factors affecting them.
5. Marketing process and functions - Marketing process - Concentration, dispersion and equalization - Thompsons classification.
6. Exchange functions – Buying and selling, methods - Physical functions – Storage, transportation and processing.
7. Facilitating functions – Packing and packaging, branding, grading, standardization, FAQs for major crop produce, quality control and labeling - AGMARK, HACCP, FSSAI, CODEX - Need for codex certification and relevance.
8. Market functionaries - Types and importance of agencies involved in agricultural marketing and their role - Producers, middlemen (merchant middlemen, agent middlemen, speculative middlemen, processors, facilitative middlemen).
9. Meaning and definition of marketing channels and supply chain management and their importance.
10. Marketing mix - Meaning, 4Ps of marketing - Product, price, place and promotion - Their importance and characteristics in agriculture.
11. Meaning and stages in PLC (Product Life Cycle) - Characteristics of PLC - Strategies in different stages of PLC.
12. Pricing and promotion strategies - Pricing considerations and approaches – Cost based and competition based pricing.
13. Market promotion – Advertising, personal selling, sales promotion and publicity – Their meaning and merits and demerits.
14. Market segmentation-Meaning and its importance, types of market segmentation and benefits.
15. Market Integration - Meaning, definition - Marketing efficiency - Meaning, definition, measurement of marketing efficiency - Types of market integration and marketing efficiency.
- 16&17. Marketing costs, margins and price spread - Meaning and measurement, factors affecting cost of marketing - Reasons for higher marketing costs of farm commodities - Ways of reducing marketing costs.
18. Regulated markets-Definition - Important features of regulated markets - Functions, progress and defects.
19. Model regulated market act, objectives and features - APMC Act in Andhra Pradesh - Objectives and features and functions

20. Govt. interventions in agricultural marketing, their need, importance, and role - Important market acts - Public sector institutions - CWC, SWC, FCI, & DMI - Objectives and functions.
21. Cooperative marketing - Meaning and its need and importance, cooperative marketing agencies in India - NAFED, MARKFED - Objectives and functions and activities.
22. Risk in marketing - Types of risk in marketing - Measures to minimize risks, speculation and hedging - Meaning, differences between speculation & hedging, advantages, disadvantages and process of speculation and hedging.
23. An overview of futures trading in agricultural commodities - Forward/future markets - Meaning, advantages and disadvantages of forward markets.
24. Commodity exchanges - Role and importance - Commodity exchanges in India - MCX, NCDX, NCMX, ACX, Safal - Role of regulatory bodies in futures markets - SEBI, etc, Contract farming - Meaning, procedures and advantages - Contract farming act in Andhra Pradesh.
25. Meaning and functions of price - Characteristics of agricultural product prices - Agricultural price stabilization - Need for agricultural price policy - Role of Commission for Agricultural Costs and Prices (CACPC) - Meaning of administered prices - Minimum support price, procurement price and issue price, levy price.
26. Concept of International Trade and its importance in globalised world economies - Free trade and protectionism - Meaning, pros and cons of free trade and protectionism.
27. Theory of absolute and comparative advantage and their importance international trade.
28. Trends, present status and prospects of Indian agri-commodities trade in international trade.
29. WTO - Genesis, objectives, functions and principles of multilateral trade.
- 30 & 31. WTO agreements - Agreement on Agriculture (AoA) - Market access, Aggregate Measures of Support (AMS), export subsidies, sanitary and phyto sanitary measures (SPS) and their implications and impact on Indian agriculture.
32. TRIPS and intellectual property rights and their implications to Indian agriculture - Meaning of patents, copy rights, trademarks, geographical indications, industrial designs, trade secrets, integrated circuits, and plant varieties protection.

### **Practical**

1. Plotting and study of demand and supply curves for major agricultural commodities.
2. Calculation of elasticities for important agricultural commodities.
3. Study of relationship between market arrivals and prices of some selected commodities.
4. Computation of marketable and marketed surplus of important commodities.

5. Study of price behaviour over time for some selected commodities.
- 6 & 7. Construction of index numbers- moving averages -General PI , WPI, CPI.
- 8 & 9. Visit to a local markets to study various marketing functions performed by different agencies, identification of marketing channels for selected commodities, collection of data regarding marketing costs.
- 10 Estimation and calculation of marketing costs, margins and price spread and presentation of report in the class.
- 11 Visit to SWC/CWC to study their objectives, role, organization, functioning and performance.
- 12 Visit to FCI and study its objectives, role, organization and functioning and performance.
- 13 Visit to cooperative marketing society – DCMS/ MARKFED, etc. to study their objectives, role, organization and functioning.
- 14 - 16. Study of comparative advantage of different agricultural commodities of India in International trade.

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- 2 S S Acharya and N L Agarwal. *Agricultural Price: Analysis and Policy*. Oxford & IBH Publications Co. Pvt Ltd., New Delhi.
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- 5 Mamoria, C.B. and Joshi. R L.1995. *Principles and Practices of Marketing in India*. Kitab Mahal, Allahabad
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**AECO 341**

**FARM MANAGEMENT, PRODUCTION  
AND RESOURCE ECONOMICS**

**2 (1+1)**

### Course outlines

#### Theory

Meaning and concept of farm management, definitions, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, changing

structure of land holdings in India and characteristics of small and marginal farm holdings. Farm management problems in India.

Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage, time comparison principle.

Meaning and concept of cost, types of costs and their interrelationship, cost function /cost-output relationship, importance of costs in managing farm business and Cost Principle.

Farm inventory, appraisal and valuation of farm resources and products, Meaning and importance of farm planning and budgeting, Partial budget, enterprise budget and complete budgeting, steps in farm planning and budgeting-linear programming,

Concept of risk and uncertainty in agriculture production, nature and sources of risks and its management strategies- Crop/livestock/machinery insurance, weather based crop insurance, features, determinants of compensation.

Concepts of Natural resource economics, differences between NRE and agricultural economics, unique properties of natural resources. Positive and negative externalities in agriculture, Inefficiency and welfare loss, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

### **Practical**

Computation of depreciation cost of farm assets. Determination of most profitable level of inputs use in a farm production process. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Farm holding survey. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Farm business analysis, Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India. Seminar on selected topics.

### **Lecture outlines**

#### **Theory**

1. Meaning and concept of farm management, definitions, objectives and relationship with other sciences - Importance of study of farm management - Farm management problems in India.
2. Meaning and definitions of types and systems of farming and their characteristics - Changing structure of land holdings in India - Characteristics of small, marginal and tenant farm holdings.
3. Concept of production function and its types, use of production function in decision -Making on a farm - Seven principles of farm management.
4. Factor - Product relationship – Law of variable proportions – Definition, graphical and arithmetical explanation with the help of an example.

5. Determination of optimum input and optimum output and decision rules.
6. Factor-Factor relationship, resources and types - Substitutes and complements, variable and fixed resources - Iso-quants - Iso-cost lines - Meaning and characteristics - Principle of least cost combination/ Principle of factor substitution - Explanation and decision rules.
7. Product-Product relationship - Iso- product curves and Iso-revenue lines - Meaning and characteristics - Principle of optimum product combination - Law of equi-marginal returns/ principles of opportunity cost, decision rules.
8. Types of enterprises and their characteristics - Principle of comparative advantage.
9. Meaning and concept of cost, cost function /cost-output relationship - Types of production costs and their interrelationship - Importance of costs in managing farm business - Minimum loss principle ( Cost Principle) and decision rules - Time comparison principle – compounding and discounting.
10. Farm inventory - Meaning and importance of taking inventory on farm business - Different methods of appraisal and valuation of farm resources and products.
11. Farm planning and budgeting - Meaning and importance, partial budgeting, enterprise budgeting and complete budgeting, steps in farm planning and budgeting.
12. Linear programming-Meaning - Definition, LP mathematical model specification, importance in farm decision making, basic assumptions, limitations.
13. Concepts of risk and uncertainty in agriculture production, nature and sources of risks and uncertainty and management strategies.
14. Economy and environmental linkages - How economic activity affects life on a planet with limited resources and a fragile environment - Concepts of natural resource economics - Ecological equilibrium, direct use value and indirect use value, willingness to accept and willingness to pay, contingent valuation, opportunity cost, discounting, societal cost - benefit analysis, consumer surplus, carbon sequestration - Unique properties of natural resources.
15. Environmental costs of economic growth - Sustainable development - Positive and negative externalities in agriculture - Inefficiency and welfare loss, solutions.
16. Important issues in economics and management of common property resources of land, water, pasture and forest resources etc. - India's environmental policy.

### **Practical**

- 1 & 2. Different methods Computation of depreciation cost of farm assets.
3. Determination of most profitable level of inputs use and output in farm production process.
4. Determination of least cost combination of inputs
5. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources.

6. Selection of most profitable enterprise combination.
- 7 & 8. Farm holding surveys.
- 9.& 10. Application of cost principles - CACP concepts in the estimation of cost of mono cropping and poly cropping and livestock enterprises.
11. Farm business analysis - Estimation of different farm income measures, technical and economic efficiency measures and breakeven analysis.
12. Preparation of partial budgets and enterprise budgets.
13. Visit to college farm and study different farm records and accounts and prepare profit and loss account.
- 14 -16. Collection and analysis of data on various natural resources in India - Land - Changes in land use pattern, forests – Water - Changes in ground water and surface water resources - Changes in labour resources - Agricultural workers - Pollution and green gas emissions - Biodiversity, etc.

### References

- 1 Bishop, C.E. and W. D. Tousaint. 1958. *Introduction to Agricultural Economic Analysis*. John Wiley and Sons, London.
- 2 Heady, Earl O. 1964. *Economics of Agricultural Production and Resource Use*. Prentice Hall of India, Private Limited, New Delhi
- 3 S.S. Johl, J.R. Kapur. 2006. *Fundamentals of Farm Business Management*. Kalyani Publishers, New Delhi.
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- 5 Kahlon, A.S. and Karam Singh. 1965. *Principles of Farm Business Management*. Kalyani Publishers, New Delhi.
- 6 Raju, V.T. and D.V.S. Rao. 2006. *Economics of Farm Production and Management*. Oxford & IBH Publishing Co. Pvt. Limited, New Delhi
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**Course outlines****Theory**

Introduction to soil and water conservation - Causes of soil erosion - Definition and agents of soil erosion - Water erosion - Forms of water erosion - Gully classification and control measures - Soil loss estimation by Universal Soil Loss Equation - Soil loss measurement techniques - Principles of erosion control - Introduction to contouring - Strip cropping - Contour bund - Graded bund and bench terracing - Grassed water ways and their design - Water harvesting and its techniques - Wind erosion - Mechanics of wind erosion - Types of soil movement - Principles of wind erosion control and its control measures.

Introduction to irrigation - Irrigation project classification - Methods of micro-irrigation - Importance of irrigation water measurements – Volumetric area velocity - Discharge methods - Weirs – Orifice – Flumes - Types of wells - Water lifting devices - Classification of pumps – capacity – Power - Discharge calculations - Open channel hydraulics - Discharge calculations - Underground pipeline systems - Functional components of micro irrigation systems and its design like drip - Sprinkler etc. - Water harvesting - Lining of ponds – Tanks - Canals.

**Practical**

General status of soil conservation in India - Calculation of erosion index - Estimation of soil loss - Measurement of soil loss - Preparation of contour maps - Design of grassed water ways - Design of contour bunds - Design of graded bunds - Design of bench terracing system - Problem on wind erosion - Discharge measurements - Irrigation pumps - Different pumps and structural differences - Design of farm ponds - Lining of ponds - Irrigation tank - Water management.

**Lecture outlines****Theory**

1. Introduction to soil and water conservation and causes of soil erosion.
2. Definition and agents of soil erosion, water erosion - Forms of water erosion - Gully classification and control measures.
3. Soil loss estimation by universal soil loss equation - Soil loss measurement techniques.
4. Principles of erosion control - Introduction to contouring, strip cropping.
5. Contour bund - Graded bund and bench terracing.
6. Grassed water ways and their design.
7. Wind erosion - Mechanics of wind erosion, types of soil movement - Principles of wind erosion control and its control measures.

8. Introduction to irrigation - Classification of irrigation projects.
9. Importance of irrigation water measurements - Volumetric, area velocity, discharge methods - Weirs, orifice, flumes.
10. Open channel hydraulics - Discharge calculations.
- 11&12. Types of wells - Water lifting devices - Classification of pumps, their capacity, power requirement and discharge calculations.
13. Functional components and working principle of underground pipeline systems.
- 14&15. Functional components of micro irrigation systems and its design like drip, sprinkler irrigation systems etc.
16. Water harvesting techniques - Lining of ponds, tanks and canal systems.

### **Practical**

1. Practicing survey - Principles and educating to use pacing technique for measurement.
- 2&3. Area calculations through chain survey - GPS demo for tracking and area measurement.
4. Estimation of soil loss and calculation of erosion index.
5. Leveling concepts and practical utility in agriculture.
6. Preparation of contour maps.
7. Concept of vegetative water ways and design of grassed water ways.
8. Construction of contour and graded bunds.
9. Wind erosion and estimation process.
- 10&11. Water discharge measurements lab exercises for computing discharge.
- 12&13. Different irrigation pumps and their constructional differences.
14. Farm pond construction and its design aspects.
15. Farm pond and canal lining and its procedures.
16. Visit to nearby farm pond.

### **References**

1. Ghanshyam Das., 2012. *Hydrology and Soil Conservation Engineering, including Watershed Management*. Second edition, PHI Learning Private Limited, New Delhi - 110001
2. Murthy, V. V.N., 2004. *Land and Water Management Engineering*. Kalayani Publishers, New Delhi
3. Michael A.M., 2007. *Irrigation Theory and Practice*. Second edition. Vikas Publishing House Pvt. Ltd.
4. Mal, B. C. 1995. *Introduction to Soil and Water Conservation Engineering*. Kalayani Publishers, Rajinder Nagar, Ludhiana
5. Kanetakar, T. P. 1993. *Surveying and Leveling*. Pune Vidyarthi Griha, Prakashan, Pune
6. Suresh, R. 2008. *Land and Water Management*. Standard Publishers Distributors, Delhi.

**Course outlines****Theory**

Status of farm power in India - Sources of farm power - I.C. engines - Working principles of I C engines - Comparison of two stroke and four stroke cycle engines - Study of different components of I.C. engine - I.C. engine terminology and solved problems - Familiarization with different systems of I.C. engines - Air cleaning – Cooling - Lubrication - Fuel supply and hydraulic control system of a tractor - Familiarization with power transmission system – Clutch - Gear box - Differential and final drive of a tractor - Tractor types - Cost analysis of tractor power and attached implement - Familiarization with primary and secondary tillage implements - Implements for hill agriculture - Implements for intercultural operations - Familiarization with sowing and planting equipment - Calibration of a seed drill and solved examples - Familiarization with plant protection equipment - Familiarization with harvesting and threshing equipment.

**Practical**

Study of different components of I.C. engine - To study air cleaning and cooling system of engine - Familiarization with clutch – Transmission - Differential and final drive of a tractor - Familiarization with lubrication and fuel supply system of engine - Familiarization with brake – Steering - Hydraulic control system of engine - Learning of tractor driving - Familiarization with operation of power tiller - Implements for hill agriculture - Familiarization with different types of primary and secondary tillage implements - Mould plough - Disc plough and disc harrow -Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration - Planters and transplanter - Familiarization with different types of sprayers and dusters -Familiarization with different inter-cultivation equipment - Familiarization with harvesting and threshing machinery.

**Lecture outlines****Theory**

1. Farm power – Source of different farm power, advantages and disadvantages.
2. Internal combustion engine - Different components and their functions - Working principle of four stroke and two stroke cycle engine - Comparison between diesel and petrol engine - Difference between four and two stroke engine.
3. Terminology related to engine power - IHP, BHP, FHP, DBHP, compression ratio, stroke bore ratio, piston displacement, and mechanical efficiency - Numerical problems on calculation of IHP, BHP, C.R., stroke bore ratio, piston displacement volume.
4. Fuel supply and cooling system of I.C. engine – Types, components and their functions, working principle of forced circulation cooling system.
5. Ignition and power transmission system of I.C engine – Types, components and their functions, working principle of battery ignition system.

6. Lubrication system of I.C. engine – Types, purpose, components and their functions, working principle of forced feed system - Tractors classification, types, points to be considered in selection of tractors, estimating the cost of operation of tractor power.
7. Tillage - Primary and secondary tillage - M.B. plough – Functions, constructional features, operational adjustments and maintenance.
8. Disc plough – Functions, constructional details, operational adjustments and maintenance.
9. Numerical problems on M.B. plough and disc plough.
10. Harrows – Types, functions, operation of disc harrows - Cultivators – Rigid and spring loaded tynes - Puddlers, cage wheel, rotovators - Intercultural implements – Hoes and weeders for dry and wetland cultivation.
11. Sowing equipment - Seed cum fertilizer drills – Types, functions, types of metering mechanisms, functional components, calibration - Paddy transplanters.
12. Harvesting equipment – Sickles, self propelled reaper, alignment and registration - Combines, functions of combines.
13. Plant protection equipment – Types of sprayers, constructional features of knapsack sprayer, hand compression sprayer, foot sprayer, rocker sprayer and power sprayer, care and maintenance of sprayers.
14. Dusters – Hand rotary and power operated dusters, care and maintenance of dusters.
15. Tractor mounted equipments for land development and soil conservation – Functions of bund former, ridger, and leveling blade.
16. Threshing equipment and principles of combine harvester.

### **Practical**

1. Showing the difference between EC engine and constructional details of IC engine.
2. Dismantling the IC engine and explaining the functional aspects of components.
3. Air cleaning and maintenance - Engine cooling and maintenance.
4. Familiarizing with lubrication and fuel supply system of an engine.
5. Familiarizing with clutch – Gearbox - Differential and final drive along with brake steering hydraulic control of tractor.
- 6&7. Tractor driving.
8. 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, disc plough and its adjustments.
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.
13. Study on planters and transplanters.
14. Practicing with plant protection equipment, different sprayers and dusters.
15. Familiarization with inter-cultural equipment and different types available in the market.
16. Exposure on harvesting equipment and combine harvesters.

## References

1. Jagadishwar Sahay - *Elements of Agricultural Engineering*.
2. Surendra Singh. *Farm Machinery - Principles and Applications*. ICAR Publication.
3. S.C.Jain and C.R.Rai. *Farm Tractor – Maintenance and Repair*. Standard Publishers, 1705-B, Nai Sarak, Delhi – 110006
4. Ojha, T. P. and Michael, A.M. *Principles of Agricultural Engineering*. Vol. I, Jain Brothers, 16/893, East Park Road, Karol Bagh, New Delhi – 110005

## **AENG 252                      RENEWABLE ENERGY AND GREEN TECHNOLOGY                      2(1+1)**

### **Course outlines**

#### **Theory**

Classification of energy sources - Contribution of non-conventional energy sources in agricultural sector - Familiarization with biomass utilization for biofuel production and its application - Familiarization with types of biogas plants and gasifiers – Biogas - Bio-alcohol - Biodiesel and bio oil production and their utilization as bioenergy resource - Introduction of solar energy - Collection and its application - Familiarization with solar energy gadgets - Solar cooker - Solar water heater - Application of solar energy - Solar drying - Solar pond - Solar distillation - Solar photovoltaic system and its application - Introduction of wind energy and their application.

#### **Practical**

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

### **Lecture outlines**

#### **Theory**

1. Introduction - Renewable energy sources, classification, advantages and disadvantages.
2. Biomass - Importance of biomass, classification of energy production - Principles of combustion, pyrolysis and gasification.

3. Biogas - Principles of biogas production, advantages, disadvantages, utilization.
4. Biogas plants - Classification, types of biogas plants, constructional details of biogas plants.
5. Types of gasifiers - Producer gas and its utilization.
6. Briquettes, briquetting machinery – Types and uses of briquettes - Shredders.
7. Solar energy – Application of solar energy, methods of heat transfer, conduction, convection and radiation.
8. Solar appliances - Flat plate collectors, focusing type collectors, solar air heater.
9. Solar space heating and cooling - Solar energy gadgets, solar cookers, solar water heating systems.
10. Solar grain dryers, solar refrigeration system, solar ponds.
11. Solar photovoltaic system - Solar lantern, solar street lights, solar fencing, solar water pumping system.
12. Wind energy - Advantages, disadvantages, wind mills and types.
13. Constructional details of wind mills, applications of wind mills.
14. Biofuels – Characteristics of various biofuels, different parameters and calorific values.
15. Bio diesel production – Applications, extraction from jatropha.
16. Ethanol from agricultural produce (sugarcane and corn).

### **Practical**

1. Availability and uses of non - conventional energy in agricultural sector.
2. Bio-fuel production from biomass and its application.
3. Practical approach to biogas production and biogas plants capacity and design calculations.
4. Running gasifiers and production details of producer gas.
5. Production details of briquettes from briquetting machine.
- 6&7. Experimenting with solar gadgets like solar-cooler and solar water heater for their performance.
8. Performance of solar photovoltaic system and observing various factors influencing efficiency of the photo-voltaic system.
9. Evaluation of solar pump for agriculture.
10. Study of solar drying system.
11. Study of solar distillation and solar pond.
12. Steps adopted for erecting solar fence.
- 13&14. Visit to solar wind farm.
- 15&16. Visit to solar photovoltaic farm.

## References

1. Rai, G.D. 2004. *Non-conventional Energy Sources*. Khanna Publishers, New Delhi.
2. Rajput, R. K. 2012. *Non-conventional Energy Sources*. S. Chand Publishers.
3. Ojha, T.P. and Michael, A.M. *Principles of Agricultural Engineering*. Vol. I, Jain Brothers, New Delhi.
4. Rathore, N.S., Mathur, A.N. and Kothari, S. *Alternate Sources of Energy*. ICAR Publication.
5. Chakravarty, A. and Amalendu Chakraverty. 1989 *Biotechnology and Other Alternative Technologies for Utilization of Biomass-Agricultural Wastes*. 1<sup>st</sup> edition, Oxford and IBH. Publishers, New Delhi

**AENG 351**

**PROTECTED CULTIVATION AND  
POST HARVEST TECHNOLOGY  
(SECONDARY AGRICULTURE)**

**2(1+1)**

### Course outlines

#### Theory

Greenhouse technology – Introduction - Types of greenhouses - Plant response to greenhouse environment - Planning and design of greenhouses - Design criteria of green house for cooling and heating purposes - Green house equipments - Materials of construction for traditional and low cost green houses - Irrigation systems used in greenhouses - Typical applications - Passive solar greenhouse - Hot air greenhouse heating systems - Greenhouse drying - Cost estimation and economic analysis.

Important engineering properties such as physical - Thermal and aerodynamic properties of cereals - Pulses and oilseeds - Their application in PHT equipment design and operation - Drying and dehydration - Moisture measurement – EMC - Drying theory - Various drying methods - Commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer) - Material handling equipment - Screw conveyer and bucket elevator - Their principle - Working and Selection - Primary processing of cereals, pulses and oilseed, like cleaning, grading, packaging etc.

#### Practical

Study of different type of greenhouses based on shape - Determine the rate of air exchange in an active summer winter cooling system - Determination of drying rate of agricultural products inside greenhouse - Study of greenhouse equipment - Visit to various post harvest laboratories - Determination of moisture content of various grains by oven drying & infrared moisture methods - Determination of engineering properties (shape and size, bulk density and porosity of biomaterials) - Determination of moisture content of various grains by moisture meter - Exposure to primary processing equipment like dalmills, graders, cold storages etc. - Field visit to seed processing plant.

## Lecture outlines

### Theory

1. Introduction to green houses - History, definition, greenhouse effect, advantages of green houses.
2. Brief description of types of green houses - Greenhouses based on shape, utility, construction, covering materials and cost, shade nets.
3. Plant response to greenhouse environments - Light, temperature, relative humidity, ventilation and carbon dioxide and environmental requirement of agriculture and horticulture crops inside green houses.
4. Equipment required for controlling green house environment – Summer cooling and winter cooling, natural ventilation, forced ventilation and computers.
5. Planning of green house facility - Site selection and orientation, structural design and covering materials.
6. Materials for construction of green houses - Wood, galvanized iron, glass, polyethylene film, poly vinyl chloride film, Tefzel T2 film, fiberglass reinforced plastic rigid panel and acrylic and polycarbonate rigid panel.
7. Design criteria and constructional details of greenhouses - Construction of pipe framed greenhouses, material requirement, preparation of materials and procedure of erection.
8. Greenhouse heating and distribution systems - Greenhouse utilization - Off-season drying of agricultural produce - Economic analysis of greenhouse production - Capital requirement, economics of production and conditions influencing returns.
9. Irrigation system used in greenhouses - Rules of watering, hand watering, perimeter watering, overhead sprinklers, boom watering and drip irrigation.
10. Important engineering properties such as physical, thermal and aero-dynamic properties of cereals, pulses and oil-seeds.
11. Designing post harvest equipment based on physical and thermal properties.
12. Winnowing - Manual and power operated winnowers, care and maintenance - Groundnut decorticators - Hand and power operated decorticators, principle of working, care and maintenance.
13. Moisture measurement - Equilibrium moisture content (EMC) – importance - Drying theory - Drying and dehydration.
14. Commercial grain dryers - Deep bed, flat bed, tray, fluidised bed, recirculated and solar dryers.
15. Material handling equipment - Bucket elevator and screw conveyer and their selection.
16. Primary processing of cereals, pulses and oilseeds - Cleaning, grading and packaging.

## Practical

1. Study of different types of green houses based on shape, etc.
2. Computing the rate of air exchange in an active summer and winter cooling systems.
3. Feasibility study on drying of agricultural products inside a greenhouse and its calculation.
4. Visit to post harvest technology units and laboratories.
5. Determination of moisture content of various grains by oven drying and infrared methods.
6. Determination of size, space, porosity, bulk density, etc., of grains.
7. Determination of aerodynamic properties of grains.
8. Cleaning and grading of grains, pulses and oilseeds.
9. Drying and dehydration of vegetables (cauliflower).
10. Visit to rice mill.
11. Study of LSU dryer.
12. Study of Bucket elevator and screw conveyor.
13. Visit to dhal mill
14. Visit to oil seed processing plant.
15. Visit to cold storage
16. Practical final examination

## References

1. Radha Manohar, K and Igathinathane. C. *Greenhouse Technology and Management*, 2<sup>nd</sup> Edition, BS Publications.
2. Tiwari, G.N. *Greenhouse Technology for Controlled Environment*. Narosa Publishing house Pvt.Ltd.
3. Singh Brahma and Balraj Singh., 2014. *Advances in Protected Cultivation*, New India Publishing Company.
4. Sahay, K.M. and Singh, K.K. 1994. *Unit operations of Agricultural Processing*. Vikas Publishing house Pvt. Ltd. New Delhi.
5. Chakraverty, A. *Post Harvest Technology of cereals, pulses and oilseeds*. Oxford & IBH publishing Co. Ltd., New Delhi.
6. Ojha, T.P and Michael, A.M. *Principles of Agricultural Engineering*, Vol. I, Jain Brothers, Karol Bag, New Delhi.

**Course outlines****Theory**

Introduction to the living world. Diversity and characteristics of life, Origin of life, Evolution and Eugenics. Binomial nomenclature and classification, Cell and cell division. Morphology of flowering plants. Seed and seed germination. Plant systematic-viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

**Practical**

Morphology of flowering plants - root, stem and leaf and their modifications. Inflorescence, flower and fruits. Cell. Tissues & cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants- Brassicaceae, Fabaceae and Poaceae.

**Lecture outlines****Theory**

1. Introduction to living world - Properties of life or living things – Growth, development and reproduction, regulation and homeostasis - Diversity of Life – Major domains/ kingdoms of living beings – Bacteria (Eubacteria), Archaea (Archebacteria) and Eukarya (Protista, fungi, plantae, animalia) - Concepts of prokaryotes and eukaryotes, unicellular and multicellular organisms, plants and animals, sporophyte and gametophyte, monocots and dicots - Salient features, classification and alternation of generations of the plants of the following groups – Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms - Evolutionary relationships and differences among different kingdoms, viruses, viroids, prions and lichens and their special features.
2. Origin of life – Theories of origin of life - Special creation, extra-terrestrial and spontaneous - Location of origin of life - Miller-Urey's experiment, Path of evolution of chemical molecules of living beings, theories of origin of cells – Endosymbiotic theory, Bubble theory.
3. Evolution and eugenics – Theories of evolution, eugenics - History, meanings and types.
4. Nomenclature of living beings - Basics in biological classification, need for classification, importance of classification, nomenclature – Polynomial, binomial and trinomial systems of nomenclature - Rules of binomial nomenclature, hierarchy of classification.
5. Cells – Cell structure and organization of plants and animals - Cell theory and cell as the basic unit of life - Overview of the cell. Prokaryotic cells, ultra structure of plant cell (structure in detail and functions in brief) - Cell membrane, cell wall, cell organelles - Morphology and function: Endoplasmic reticulum, mitochondria, plastids, ribosomes, golgi bodies, vacuoles, lysosomes, microbodies, centrosome and centriole, cilia, flagella, cytoskeleton and nucleus.

6. Chromosomes -Number, structural organization -Nucleosome.
7. Cell cycle, cell division - Somatic cell division or mitosis – Stages and phases - Reproductive cell division or meiosis – Stages and phases and significance.
8. Morphology of flowering plants - Roots - Characters, types and modifications of roots, basic external and internal structural organization of root in monocots and dicots.
9. Morphology of flowering plants - Stems - Characters, functions and modification of stems - Basic external and internal structural organization of stem in monocots and dicots.
10. Morphology of flowering plants - Leaf - Parts, functions, types and modifications of leaves - Leaf venation and phyllotaxy.
11. Morphology of flowering plants - Inflorescence - types of inflorescences, types of racemose inflorescence, types of cymose inflorescence - Special types of inflorescences.
12. Morphology of flowering plants - Flower - Structure and parts of flower, types of flowers based on sex distribution, structural symmetry, position of gynoecium, aestivation - Description of types of calyx, corolla, stamens and ovary; Seed - Structure and organization of seed in monocots and dicots - Seed germination - Necessary conditions for germination.
13. Plant systematics – Brassicaceae - Distribution, important plants, economic importance, vegetative and floral characters, pollination, fruit and seed characters.
14. Plant systematics - Fabaceae - Distribution, important plants, economic importance, vegetative and floral characters, pollination, fruit and seed characters.
15. Plant systematics - Poaceae - Distribution, important plants, economic importance, vegetative and floral characters, pollination, fruit and seed characters.
16. Role of animals in agriculture–Animals of draught and milch, fur, wool, etc. - Different animal products used as manure.

### **Practical**

1. External morphology of monocot roots - Rice and maize.
2. External morphology of dicot roots - Brassica and any legume.
3. External morphology of monocot stem - Rice and maize.
4. External morphology of dicot stem - Brassica and any legume.
5. External morphology of monocot leaf - Rice and maize.
6. External morphology of dicot leaf – Brassica and any legume.
7. Structure and organization of plant cell.
8. Study of different types of tissue systems - Parenchyma, collenchyma and sclerenchyma.
9. Study of mitosis through onion root tip cells.

10. Study of meiosis through onion anther cells.
11. Internal anatomy of monocot stems and roots - Rice and maize.
12. Internal anatomy of dicot stems and roots - Brassica and any legume.
13. Internal anatomy of ovary of monocots and dicots - Any millet and legume.
14. Description of Brassicaceae with live specimens.
15. Description of Fabaceae with live specimens.
16. Description of Poaceae with live specimens.

### References

1. *Biology* – Raven P, Mason Johnson G B, Losos J. B, Singer. S.S , 10<sup>th</sup> edition, 2014. McGraw Hill Publications.
2. M.G. Simpson, 2006. *Plant systematics*. Elsevier Publications
3. H. C. Gangulee 1972 *College Botany* 4<sup>th</sup> edition.
4. A. C. Dutta 1964 *A class book of Botany Botany for Degree Students*, Oxford University Press, Calcutta.
5. N. T. Gill. 1966. *Agricultural Botany*. 2<sup>nd</sup> edition.

**CPHY-162**

**FUNDAMENTALS OF CROP PHYSIOLOGY**

**3(2+1)**

### Course outlines

#### Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; seed physiology: seed structures, seed development seed viability and vigour, Physiological maturity, seed germination. Physiological aspects of growth and development: Growth analysis. Diffusion and osmosis; Absorption of water, transpiration and Stomatal complex; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; assimilation of mineral nutrients: nitrate, ammonium, Biological nitrogen fixation. Photosynthesis: Light and Dark reactions, C3, C4 and CAM plants; Respiration: energy balance, significance, OPPP pathway. Lipids: Biosynthesis and functions of lipids, significance in plant metabolism; Physiology of flowering; Photoperiodism, importance classification of plants based on photoperiodism, biological clock. Phytochrome, vernalization importance. Plant growth regulators: Biosynthesis, Mode of action, Physiological roles and commercial uses in agriculture. Senescence and Abscission: definition, types, changes that occur during senescence, abscission versus senescence. Post harvest physiology: dormancy, fruit ripening, physiology of cut flowers.

#### Practical

Solutions- Preparation, Seed vigor and viability tests, optimum conditions for seed germination, leaf area measurement, Growth analysis, Measurement of water status in plants, Measurement of water potential, Measurement of Stomatal frequency and index

photosynthetic pigments- Absorption spectrum , Leaf anatomy of C3 and C4 plants, Measurement of photosynthesis – Hill's reaction, Measurement of photosynthesis by IRGA, Effect of plant growth regulators on plant growth. Diagnosis of nutrient deficiency symptoms in crops, Yield analysis

## Lecture outlines

### Theory

1. Introduction to Crop Physiology and its importance in Agriculture.
- 2 & 3. Plant cell - The endomembrane system - Plasma membrane, endoplasmic reticulum, nuclear envelope, golgi apparatus, vacuole and endosomes - Structure and functional characteristics - Plastids, mitochondria, oil bodies, peroxisomes and glyoxysomes - Structure and functions.
- 4 & 5. Metabolic changes during seed development - Seed viability and seed vigor - Tests of viability and vigor - Physiological maturity, harvestable maturity - Indices of physiological maturity in crops - Seed germination - Metabolic changes during seed germination.
6. Growth and Development - Definition - Growth analysis - Growth parameters - Definitions and mathematical formulae
- 7, 8 & 9. Absorption of water - Diffusion and osmosis - water potential and its components - Importance of water potential – Active and passive uptake of water – Stomatal complex – Transpiration – Water use efficiency – Water use efficiency of C3, C4 and CAM plants – Water requirement / Transpiration ratio – Factors affecting WUE.
- 10 to 13. Mineral nutrition of plants – Essential mineral elements – Criteria of essentiality of mineral elements – Mengel's classification of mineral nutrients - Nutrient uptake mechanisms - Functional roles of N, P, K, S Ca and Mg – Functional roles of Fe, Mn, Cu, Zn, B, Mo, Cl, Na, Co and Si –Deficiency symptoms of macro and micro nutrients.
- 14 & 15. Assimilation of mineral nutrients – Nitrate assimilation – Ammonium assimilation in plants – Biological nitrogen fixation – Free-living and symbiotic bacteria – Nodule formation – Nitrogenase enzyme complex.
- 16 to 19. Photosynthesis – Reactions of photosynthesis – Energy synthesis – Principle of light absorption by plants – Light reactions - Cyclic and non cyclic photophosphorylation – CO<sub>2</sub> fixation – C3 and C4 pathways – Significance of C4 pathway – CAM pathway and its significance – Photorespiration and its significance – Photosynthetic efficiency of C3, C4 and CAM plants - Factors affecting photosynthesis (light, CO<sub>2</sub> , temp and water stress) - Relationship of photosynthesis and crop productivity.
20. Respiration – Energy balance – Significance of respiration – Oxidative Pentose Phosphate Pathway (OPPP) and its significance – Growth respiration and maintenance respiration – Alternate respiration – Salt respiration – Wound respiration.

21. Lipid metabolism – Biosynthesis of fatty acids in plastids – Functions of lipids – Significance of lipids in plant metabolism.
- 22 & 23. Physiology of flowering – Photoperiodism and flowering – Importance of photoperiodism – Classification of plants based on photoperiodic responses – Perception of photoperiodic stimulus – Biological clock – Phytochrome – Flowering hormones – Vernalization and flowering – importance of vernalization in agriculture.
- 24 to 29. Plant growth regulators – Auxins – Occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses.– Gibberellins – occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses – Cytokinins – Occurrence, transport, biosynthesis, mode of action and physiological roles – commercial uses – ABA – Occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses – Ethylene – Occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses.
30. Senescence and abscission – Definition – Classification of senescence – Physiological and biochemical changes that occur during senescence – Prevention of leaf and flower senescence – Abscission and its relationship with senescence.
- 31 & 32. Post harvest physiology – Dormancy – Types of dormancy – Advantages and disadvantages of dormancy – Causes of dormancy – Remedial measures for breaking seed dormancy – Fruit ripening – Climacteric and non climacteric fruits – Metabolic changes during fruit ripening – Hormonal regulation of fruit ripening – Ripening induction and ripening inhibition – Use of hormones in increasing vase life of flowers.

## References

1. Taiz, L. and Zeiger, E. 2010. *Plant Physiology* 5<sup>th</sup> edition, Sinauer Associates, Sunderland, MA, USA.
2. Gardner, F.P., Pearce, R.B., and Mitchell, R.L. 1985. *Physiology of Crop Plants*. Scientific Publishers, Jodhpur.
3. Noggle, G.R. and Fritz, G.J., 1983. *Introductory Plant Physiology*. 2<sup>nd</sup> Edition. Prentice Hall Publishers, New Jersey, USA.

**CPHY-261**

**ECOPHYSIOLOGY**

**2(1+1)**

## Course outlines

### Theory

Ecophysiology, introduction, importance in agriculture .Ecosystem, structure, components, types of ecosystem, types of food chains, pathways of energy in the biosphere, Global climates and crop distribution, important climatic regions of the world, India and Andhra Pradesh. Environment definition ,components, abiotic

environment, biotic factors, edaphic, physiographic and pyric factors. Physiological approaches for Climate Resilient Agriculture. Competition, types, monoculture and polyculture, Navadhanya Concept - multistoried cropping system,

Allelopathy concept, mode of action, scope, sources of allelopathic chemicals in crop and weed species, Phyto-remediation, – concept – applications in agriculture. Pollution, air, soil and water pollution physiological effects on plants and its management. Global warming, causes, greenhouse gases, impact of global warming on climate and agricultural productivity, Controlled environment, designs of structure, types, commercial applications. Carbon dioxide fertilization, concept, effects on crop yields and limitations, Ecophysiological models for different environmental management.

### **Practical**

Morphological and anatomical adaptations of plants grown in for different ecological habitation, Morphological and anatomical adaptations of crop plants grown in for different abiotic stresses and controlled environment

### **Lecture outlines**

#### **Theory**

- 1 Ecophysiology – Introduction – Definition – Importance in agriculture and horticulture – Ecosystem – Definition of ecosystem, ecotypes and ecads – Biosphere and ecosystem – Sub divisions of biosphere – Pathways of energy in the biosphere – Concept of ecosystem – Components of ecosystem – Basic structure of ecosystem.
- 2 Different types of ecosystem – Freshwater, marine, forest and crop ecosystem – Energy in ecosystem – Productivity – Primary production – Secondary production – Types of food chains.
- 3 Global climates and crop distribution – Influence of climate on crop distribution (rice, wheat, maize, sorghum and sugarcane) – Important climatic regions of the world – Agro-climatic zones of India – Crop distribution in India and Andhra Pradesh.
- 4 Environment – Definition – Components – Biotic and abiotic environments – Biotic environment – Biotic factors and anthropic factors – Abiotic environment – Climatic, edaphic, physiographic and pyric factors – Climatic factors – Radiation – Effect of radiation on plant functions – Classification of ultraviolet (UV) radiation – Effects of UV-B radiation.
- 5 Abiotic environment – Climatic factors – Precipitation – Forms of precipitation – Effect of water deficit and water logging on plant processes – Temperature – Cardinal temperature – Effects of temperature on plant processes – Temperature injuries – High temperature and low temperature stress – Classification of plants based on heat resistance and cold resistance – Heat units.
- 6 Edaphic factors – Classification of plants based on adaptation to different soil types – Halophytes and salt stress tolerance mechanisms.
- 7 Physiographic factors – Altitude of the place, steepness of the slope, direction of

- mountain chain and exposure of the slope to light and wind – Effects of topographic factors on vegetation – Wind effect on physiological processes - Pyric factors – sources and type of fires – Effects of fire on vegetation and environment – management of fires and rejuvenation of crops.
- 8 Biotic factors – Herbivores (grazing effect), symbiosis (Mycorrhiza and Rhizobium associations), insectivorous plants, epiphytism and parasites - Anthropic factors – Industrialization – Shifting cultivation – Crop improvement.
  - 9 Physiological approaches for climate resilient agriculture.
  - 10 Competition – Ecological succession – Dominance and subordination – Types of competition – Inter-specific, intra-specific and intra-plant competition – Monoculture and polyculture – Multistoried cropping system – Mutual shading.
  - 11 Allelopathy – Definition – Concept – Sources of allelopathic chemicals in crop and weed species – Natural products identified as allelopathic chemicals – Mode of action – Scope for allelopathy.
  - 12 Phyto-remediation – Definition – Concept – Applications in agriculture and industry.
  - 13 Pollution – Air pollution – Sources – Physiological effects on plants and its Management - Water pollution – Sources – physiological effects on plants and its Management - Soil pollution – Sources – Physiological effects on plants and its Management.
  - 14 Global warming – Greenhouse effect – Causes of global warming – Methane, carbon dioxide, chloro fluoro carbons' (CFC), nitrous oxide (NO) gas and ozone – Impact of global warming on climate and agricultural productivity – Measures to reduce build up of green house gases.
  - 15 Controlled environment – Purposes – Types – Designs of structure – Commercial applications.
  - 16 Carbon dioxide fertilization – Definition – Concept – Importance – Sources – Methods of CO<sub>2</sub> fertilization – Effects on crop yields and limitations - Ecophysiological models - Concept – Models for different environmental management.

### **Practical**

1. Hydrophytes - Morphological and anatomical adaptations to Excess water
2. Mesophytes - Morphological and anatomical adaptations to mesic conditions
3. Xerophytes - Morphological and anatomical adaptations to Water deficient
4. Effects of light and shade on crop growth
5. Influence of different soils on crop growth
6. Analysis of competition in crop plants
7. Measurement of microclimate in contrast crop canopies
8. Effect of dust pollution on crop growth
9. Effect of soil pollution on crop growth

10. Measurement of Biological Oxygen Demand ( BOD) in polluted water
11. Effect of water pollution on crop growth
12. Effect of water stress on plant growth and development
13. Effect of water logging on plant growth
14. Effect of temperature on plant growth
15. Effect of polyhouse on crop growth
16. Growing plants in controlled environment ( growth cabinet )

### References

1. Agrwal, A. K. and Deo, P.P. 2013. *Plant Ecology*. Agrobios (India) Jodhapur
2. Varshneya, M. C and Balakrishna Pillai, P. 2006. *Textbook of Agricultural Meteorology*. ICAR, New Delhi
3. Lenka, S., Lenka, N.K., Kundu, S and Subba Rao, A. 2013. *Climate change and Natural Resources Management*, New India Publishing Agency, India
4. Prasad and Kumar. 2010. *Green House Management for Horticulture Crops*. Agrobios, Jodhpur.
5. Schulze, E.C., Beck, E and Muller-Hohenstein, K. 2005. *Plant Ecology*. Springer Science & Business Media, New York City

**CPHY-361**

## **ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT**

**2(1+1)**

### Course outlines

#### Theory

Multidisciplinary nature of environmental studies: Scope and importance.

Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Case studies. f) Land resources: Land as a resource, land degradation, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of

biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies.

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

Social Issues and the Environment from Unsustainable to Sustainable development, Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. HIV/AIDS. Role of Information Technology in Environment and human health.

## **Practical**

Collection, processing and storage of effluent samples, Estimation of total dissolved solids, Hardness, dissolved oxygen, BOD and COD in waste water sample, heavy metals analysis in sludge and waste water sample, Determination of sound level, Air analysis for particulate matter, Estimation of species abundance of plants, Measurement of chlorophyll, Transpiration and water balance in plants under polluted conditions, Visit to a local polluted site, in-situ or ex-situ conservation center/ Environmental Education Centre/ Social Service Organization, ICT in Environmental Science.

## **Lecture outlines**

### **Theory**

- 1 Environmental studies - Definition – Scope and importance, need for public awareness, people and institutions in environment.
- 2 Natural resources – Renewable and non renewable resources – Forest resources –Functions of forests – Causes and consequences of deforestation.
- 3 Water resources – Sources, uses and over utilization of surface and groundwater - Dams – Benefits and problems – Sustainable management of water.
- 4 Food resources – Food sources, world food problems and food security.
- 5 Energy resources – Renewable and non-renewable energy sources and their impact on environment.

- 6 Land resources – Land degradation, desertification and land use planning – Role of an individual in conservation of natural resources.
- 7 Biodiversity – Definition – Types of biodiversity – Bio-geographical classification in India – Methods of measuring biodiversity – Biodiversity Act – Functions of National Biodiversity Board.
- 8 Threats to biodiversity – Habitat loss – Poaching of wild life – Man-wild life conflicts – Conservation of biodiversity – In situ and ex situ.
- 9 Environmental pollution – Causes, effects and control measures of air and water pollution – Tolerable limits for toxic gases in air.
- 10 Causes, effects and control measures of soil pollution – Bioremediation – Tolerable limits for heavy metals in soil.
- 11 Causes, effects and control measures of thermal, marine and noise pollution, nuclear hazards.
- 12 Solid waste management – Need of waste management – Types of solid waste – Management processing technologies.
- 13 & 14 Disaster management - Natural Disasters – Meaning and nature of natural disasters, types and effects - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves - Man made disasters – Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. – International strategy for disaster reduction - Concept of disaster management - National disaster management framework - Financial arrangements - Role of NGOs, community based organizations and media, Central, state, district and local administration, Armed forces, police and other organizations in disaster response.
15. Social issues and the environment – Unsustainable to sustainable development – The Environment Protection Act – The air (prevention and control of pollution) act - The water (prevention and control of pollution) act – The wildlife protection act - Forest conservation act.
- 16 Woman and child welfare – Human immuno-deficiency virus (HIV)/ Acquired Immunodeficiency Syndrome (AIDS) – Role of information technology on environment and human health.

### **Practical**

1. Collection, processing and storage of effluent samples
2. Determination of chemical oxygen demand in waste water sample
3. Estimation of dissolved oxygen in waste water sample
4. Determination of total dissolved solids in waste water sample
5. Analysis of temporary hardness of waste water sample by titration
6. Analysis of total hardness of waste water sample by titration

7. Preparation of sludge / waste water sample for analysis of heavy metals
8. Estimation of heavy metals in sludge / waste water by Atomic Adsorption Spectrophotometer (AAS)
9. Determination of sound level by using sound level meter
10. Estimation of species abundance of plants
11. Estimation of respirable and non – respirable dust in air by using dust sampler
12. Study of transpiration and water balance in plants
13. Assessment of chlorophyll content in plants
14. Visit to in-situ or ex-situ conservation center / Social Service Organization / Environmental Education Centre
15. Information and Communication Technology (ICT) in Environmental Science
16. Visit to a local polluted site – observations and remedial measures

### **References**

1. Bharucha, E. 2005. Text book of Environmental Studies for undergraduate courses. University Grants Commission, New Delhi.
2. Anjaneyalu, Y. 2004. Introduction to Environmental Science. BS Publications, Hyderabad, A.P. India.

**Course outlines****Theory**

Importance of plant diseases, scope and objectives of Plant Pathology. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes.

Fungi: General characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes.

Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction.

Viruses: nature, architecture, multiplication and transmission.

Study of phanerogamic plant parasites.

Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, Anguina etc.)

**Practical**

Microscopy, General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Study of morphological features and identification of plant parasitic nematodes. Extraction of nematodes from soil.

**Lecture outlines****Theory**

1. Introduction to Plant Pathology - Definition of Plant Pathology, Plant Pathogen, Plant Disease, Symptom, Disorder. Importance of plant diseases- Brief mention of Important epidemics of international importance – Irish Famine (1845), Bengal Famine (1942), Coffee rust (1868), Wheat Rust (1940), Southern Corn Leaf blight in USA. Epidemics of local significance - Peanut Stem Necrosis Disease (Anantapur dt), Mung bean yellow mosaic virus (AP) etc. Brief mention of economic importance of micro organisms. Scope and objectives of Plant Pathology.
2. Important plant pathogenic organisms with one or two examples of important plant diseases caused by them- fungi (rice blast, wheat rust), Chromista (*Pythium* damping off, late blight of potato protozoa (coffee phloem necrosis, club root of crucifers) bacteria (rice bacterial leaf blight (BLB), cotton black arm), fastidious

vascular bacteria (sugarcane ratoon stunt, citrus greening), Phytoplasma (sugarcane grassy shoot, sesamum phyllody), *Spiroplasma* (corn stunt), viruses (TMV, MYMV), viroids (potato spindle tuber viroid, coconut cadang cadang).

3. Important plant pathogenic organisms with one or two examples of important plant diseases caused by them (contd)- algae (red rust), phanerogamic plant parasites (*Cuscuta*, *Striga*, *Orabanche*, *Loranthus*), nematodes (root knot and cyst nematode). Diseases and symptoms due to abiotic causes (khaira, cotton purple leaf, tomato blossom end rot, black heart of potato).
4. General characteristics of fungi, fungus definition. Somatic structures - types of fungal thalli - plasmodium, unicellular and filamentous. Types of fungi based on reproductive structures - eucarpic, holocarpic. Types of fungi based on their physical presence on or in the host - ectophytic and endophytic (intercellular, intracellular and vascular). Septation in fungi – Primary, adventitious, perforated and dolipore septa. Fungal tissues - plectenchyma (prosenchyma and pseudoparenchyma).
5. Modifications of mycelium (rhizomorphs, sclerotium, stroma, haustorium, rhizoids and appressorium). Ultra structure of fungal cell. Fungal nutrition - groups of fungi based on mode of nutrition - saprophytes (obligate saprophytes and facultative parasite), parasites (obligate parasites and facultative saprophytes) and symbionts (mycorrhizae and lichens).
6. Reproduction in fungi - asexual reproduction (mitospores)- fragmentation (arthrospores, oidia, chlamydo spores), fission, budding (blastospores), and sporulation –Sporangium, sporangiole, merosporangium. Spores- Plano and Aplanospores. Planospores – flagellum structure, types of flagella-tinsel, whiplash, Monoflagellate, Biflagellate, Anisokont and Heterokont zoospores. Conidiophore and Conidiospores (conidia). Asexual fruiting bodies with examples.
7. Sexual reproduction – Phases in sexual reproduction, (meiospores). Methods of plasmogamy-planogametic copulation, gametangial contact, gametangial copulation, spermatization and somatogamy. Various life cycle patterns displayed by fungi – haplobiontic haploid, haplobiontic haploid (modified), haplobiontic diploid and diplobiontic life cycles with examples. Parasexual cycle. Sexual spores in fungi.
8. Taxonomy - Nomenclature, Binomial system of nomenclature, rules of nomenclature, Classification of fungi as per Kirk *et al* (2008)- Key to phylum, sub-phyla, classes, orders and families.
9. Major characteristic features of Kingdom Fungi, Chromista and Protozoa. Characteristics of Phyla Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota and Mitosporic fungi (Anamorphic fungi) in Kingdom Fungi.
10. Kingdom Fungi – Phylum Chytridiomycota, Class Chytridiomycetes - important characteristics of Order Chytridiales – Family Synchytriaceae – disease caused by *Synchytrium endobioticum* (potato wart).

11. Phylum Zygomycota – Subphylum Mucoromycotina – Order Mucorales – Family Mucoraceae, Genus *Rhizopus*, Example of disease caused by *Rhizopus arrhizus* (Head rot of sunflower). Family Choanephoraceae, Genus *Choanephora*. Example of disease caused by *Choanephora cucurbitarum* (Choenophora blight of chillies).
12. Phylum Ascomycota - important characteristics of the phylum. Different types of ascocarps. Stile structures in ascocarps. Ascospore development in *Pyronema omphaloides*. Morphology of asci. Types of asci based on structure of ascus wall , asci arrangement -fascicle, hymenium.
13. Phylum Ascomycota, subphylum Taphrinomycotina (=Archiascomycetes) – Class Taphrinomycetes – Order Taphrinales, (i) Family Taphrinaceae - diseases caused by *Taphrina deformans* (peach leaf curl)and*T. maculans*(turmeric blotch). (ii) Family Protomycetaceae – Disease caused by *Protomyces macrospores* (stem gall of coriander).
14. Phylum Ascomycota Subphylum Pezizomycotina – (i) Class Eurotiomycetes – Subclass Eurotiomycetidae Order Eurotiales – Genera *Eurotium*, *Emericella* (*Aspergillus flavus* – aflatoxins), *Talaromyces* (*Penicillium italicum* – citrus blue mold). (ii) Class Leotiomycetes Order Erysiphales Family Erysiphaceae - *Erysiphe*, *Leveillula*, *Phyllactinia*, *Uncinula*, *Sphaerotheca*, *Podosphaera* and *Microsphaera* (key for genera of Erysiphaceae based on position of fungus on/in the host, conidial stages, number of asci per cleistothecium and cleistothecial appendages) – Important diseases caused by each of the genera. Order Helotiales Family Sclerotiniaceae Genus *Sclerotinia* (*Sclerotinia sclerotiorum* – white mold of vegetables).
15. Phylum Ascomycota, Subphylum Pezizomycotina –(iii) Class Sordariomycetes, Subclass Sardariomycetidae Order Diaporthales Family Cryphonectriaceae, Genus *Cryphonectria* (chestnut blight). Subclass Hypocreomycetidae Order Hypocreales - Family - Clavicipitaceae, Genus – *Claviceps* (ergot of sorghum and bajra).Family –Hypocreaceae – Genus – *Hypocrea* (Anamorph – *Trichoderma*,biocontrol agent).(iv) Class Dothidiomycetes Subclass – Dothidiomycetidae Order – Capnodiales – Family – Mycosphaerellaceae – Genus – *Mycosphaerella* (*M. arachidicola* (Groundnut early leaf spot), *M. personata* (Groundnut late leaf spot), *M. pinodes* (Ascochyta blight of chickpea). Order – Myriangiales – Family – Elsinoaceae – Genus – *Elsinoe* (*E. ampelina* – Grape anthracnose). Subclass – Pleosporomycetidae – Order – Pleosporales Family – Venturiaceae – Genus – *Venturia* (*V. inaequalis* – Apple scab). Family– *Pleosporaceae* – Genus– *Cochliobolus* (*C. miyabeanus* – brown spot of rice).
16. Phylum Basidiomycota – important characteristics – Primary, Secondary and Tertiary mycelium, dolipore septum, clamp connections. Development of basidium and basidiospores,parts of basidium, dispersal of basidiospores, structure of *Agaricus bisporus* basidiocarp .
17. Phylum Basidiomycota-Subphylum 1. Pucciniomycotina -Class Pucciniomycetes Order Pucciniales -Family –Pucciniaceae- Genera *Puccinia* (*three rusts of wheat*,

groundnut rust) *Uromyces* (rust of green gram and black gram). Family - Melampsoraceae -Genus *Melampsora* (*M. ricini* – castor rust). *Incertae sedis* (no family), *Hemileia* (*H. vastatrix* – coffee rust), Class Microbotryomycetes (Pucciniomycetous smuts)- Order -Microbotryales -Family Microbotryaceae - Genus -*Sphacelotheca* (Sorghum grain smut, loose smut and head smut of sorghum).

18. Macrocytic, microcytic, demicytic rusts; Autoecious and Heteroecious rusts with examples. Life cycle of *Puccinia graminis tritici*.
19. Phylum Basidiomycota – Subphylum 2. Ustilaginomycotina Class Ustilaginomycetes Order Ustilaginales - *Ustilago* (loose smut of wheat, sugarcane whip smut) and *Tolyposporium* (bajra smut). Order Urocystidales -Family - Urocystidaceae -Genus *Urocystis* (Onion smut). Class Exobasidiomycetes Order Tilletiales -Family -Tilletiaceae -Genera *Tilletia* (wheat bunts), *Neovossia* (Karnal bunt of wheat). Order Exobasidiales –Family-Exobasidiaceae –Genus *Exobasidium* (Tea blisterblight).
20. Differences between rust and smut fungi. Differences between smuts and bunts Phylum Basidiomycota – Subphylum 3. Agaricomycotina Class Agaricomycetes - *Incertae sedis* (no sub class) Order Polyporales- Family Ganodermataceae -Genus *Ganoderma* (coconut root rot and wilt).
21. Anamorphic Fungi (Mitosporic fungi = Fungi Imperfecti) Characteristics. Saccardoan spore group system. (1)Hyphomycetous anamorphic fungi: Identification features of Genera *Alternaria* (sunflower and sesamum leaf blight), *Botrytis* (castor grey mold), *Helminthosporium* (maize turcicum leaf blight), *Bipolaris* (rie brown spot), *Cercospora* (groundnut early leaf spot), *Phaeoisariopsis* (groundnut late leaf spot), *Fusarium* (cotton wilt), *Pyricularia* (rice blast), *Verticillium* (cotton wilt), Mycelia Sterilia – *Rhizoctonia* (rice sheath blight, dry root rot), *Sclerotium* (stem rot of groundnut).
22. Acervular Imperfect Fungi – *Colletotrichum* (sugarcane red rot), *Pestalotiopsis* (coconut grey leaf spot), *Pestalotia* (guava leaf spot), *Gloeosporium* (grape anthracnose). Pycnidial Imperfect Fungi – *Ascochyta* (chickpea blight), *Phoma* (blackleg of crucifers), *Phomopsis* (brinjal fruit rot), *Phyllosticta* (ginger leaf spot), *Macrophomina* (dry root rot) *Diplodia* (rose dieback), *Botryodiplodia* (cirus stem end rot), *Septoria* (leaf spot of tomato).
23. Kingdom Chromista: Characteristics of Phylum Oomycota. Important characteristics of Class Oomycetes, Subclass- Peronosporomycetidae. Order Pythiales -Family -Pythiaceae –Genus-*Pythium* (damping off of nursery crops). Order Albuginales -Family -Albuginaceae -Genus -*Albugo* (white rust).
24. Order Peronosporales- Family -Peronosporaceae - Genus -*Phytophthora* (late blight of potato). Downy mildew fungi *Sclerospora* (green ear of bajra), *Peronospora* (blue mold of tobacco), *Peronosclerospora* (sorghum downy mildew), *Pseudoperonospora* (cucurbit downy mildew), *Plasmopara* (grape downy mildew) and *Bremia* (lettuce downy mildew) Sporangiphore branching and sporangial characteristics of downy mildew genera.

25. Characteristics of Class Plasmodiophorea in Kingdom Protozoa. Important characteristics of Order Plasmodiophorida, Family Plasmodiophoraceae - differences in the characteristics of *Plasmodiophora* (club root of cabbage) and *Spongospora* (potato powdery scab).
26. Prokaryotes – Characteristics of phytopathogenic bacteria, Classification (2<sup>nd</sup> Edition of Bergey's Manual of Systematic Bacteriology, 2004). Identification of plant pathogenic bacteria based on morphological features. Domain Bacteria – Phyla Proteobacteria, Firmicutes and Actinobacteria Phylum Proteobacteria – Class Alphaproteobacteria- Order- Rhizobiales- Family -Rhizobiaceae -Genus - *Agrobacterium* (crown gall of stone fruits). Also *Candidatus Liberobacter* (citrus greening).
27. Class Betaproteobacteria -Order -Burkholderiales -Family -Burkholderiaceae Genus *Ralstonia* (bacterial wilt of solanaceous crops). Gammaproteobacteria - Order -Xanthomonadales -Family -Xanthomonadaceae -Genera -*Xanthomonas* (BLB, BLS, citrus canker), *Xylella* (Pierce's disease of grapes). Order Pseudomonadales -Family -Pseudomonadaceae -Genus -*Pseudomonas* (wild fire of tobacco). Order *Enterobacteriales*-Family- *Enterobacteriaceae*-Genera-*Erwinia* (Apple fire blight), *Pectobacterium* (Soft rot of vegetables).
28. Phylum Firmicutes. -Class Bacilli -Order -Bacillus -Family -Bacillaceae -Genus - *Bacillus* (Class Mollicutes Order Entomoplasmatales -Family -Spiroplasmataceae -Genus *Spiroplasma* (Corn stunt). Order –Acholeplasmatales- Family -Acholeplasmataceae -Genus -*Candidatus Phytoplasma* (Sesamum phyllody, Brinjal little leaf). Phylum Actinobacteria -Class -Actinobacteria -Order -Actinomycetales -Family -Microbacteriaceae -Genus -*Clavibacter* (Wheat yellow ear rot/tundu, sugarcane ratoon stunt).Family Streptomycetaceae Genus *Streptomyces* (Potato scab).
29. Viruses and viroids - important characteristics of plant viruses and viroids - multiplication - classification of viruses based on nucleic acid (single stranded (ss) RNA, double stranded (ds) RNA, ssDNA and dsDNA). Taxonomy based on ICTV (2005). Important plant viral diseases - Tobacco Mosaic Virus (TMV) and Rice Tungro Virus (RTV).
30. Methods of transmission of plant viruses with examples of vector transmitted virus diseases. Examples of important viroid diseases - potato spindle tuber viroid and coconut cadang cadang. Study of phanerogamic plant parasites with suitable examples – *Cuscuta*, *Orabanche*, *Striga*, *Loranthus*.
31. **Nematodes**-Economic importance in agriculture - General characters of plant parasitic nematodes – classification.
32. **Nematodes**- symptoms and nature of damage caused by plant nematodes (*Heterodera*, *Meloidogyne*, *Anguina*, *Ditylenchus*, *Tylenchorhynchus*, *Aphelenchoides* etc.).

## Practical

1. Microscopy - study of the parts of microscope.
2. Study of vegetative structures of fungi and their modifications.
3. Study of reproductive (sexual and asexual) structures of fungi.
4. Study of Zygomycetous fungus – *Rhizopus*, *Choanephora*.
5. Study of downy mildew fungi – *Sclerospora*, *Peronosclerospora*, *Pseudoperonospora*, *Peronospora*, *Plasmopara* and *Bremia*. Study of *Pythium*, *Phytophthora* and *Albugo*.
6. Study of powdery mildew fungi – *Oidium*, *Oidiopsis*, *Ovulariopsis*.
7. Study of ascocarps of *Erysiphe*, *Phyllactinia*, *Uncinula*, *Podospaera* and *Microspora*.
8. Study of rust fungi – *Puccinia* (different stages), *Uromyces*, *Hemileia* and *Melampsora*.
9. Study of smut fungi – *Sphacelotheca*, *Ustilago* and *Tolyposporium*. Study of *Ganoderma* and *Agaricus*.
10. Study of acervulous imperfect fungi – *Colletotrichum* and *Pestalotiopsis*. Study of pycnidial imperfect fungi – *Septoria*.
11. Study of imperfect fungi – *Aspergillus*, *Penicillium* and *Pyricularia*, *Helminthosporium*, *Alternaria*.
12. Study of imperfect fungi – *Cercospora* and *Phaeoisariopsis*, *Fusarium*, *Rhizoctonia* and *Sclerotium*.
13. Isolation of phytopathogenic bacteria (locally available diseased plant material) and study of colony characteristics.
14. Demonstration of mechanical transmission of plant viruses.
15. Extraction of plant parasitic nematodes from soil.
16. Study of morphological features and identification of plant parasitic nematodes.

## References: For Fungi:

1. Dube, H. C. 2013. *An Introduction to Fungi. 4<sup>th</sup> (Edition)*. Scientific Publishers, Jodhpur, India. (major text book)
2. Webster, J. 1989. *Introduction to fungi*. Cambridge Univ. Press (for life cycles of Fungi)
3. Dasgupta, M. K. 1987. *Principles of Plant Pathology*. Allied Publ. Pvt Ltd. p985. (for rust life cycles)
4. Students are also advised to refer *Introductory Mycology* by Alexopoulos, Mims and Blackwell (4<sup>th</sup> Edition) for Fungi.
5. For Bacteria, Viruses, Viroids, Phanerogamic Plant Parasites, Nematodes
6. Agrios, G. N. 2006. *Plant Pathology*. Elsevier Publishers, New Delhi.

**Course outlines****Theory**

History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Cause and classification of plant diseases. Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

**Practical:**

Acquaintance with various laboratory equipments, preparation of media, isolation and Koch's postulates. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations. Bioassay of fungicides, Bio-control of plant pathogens, Incubation of Trichoderma, Pesticide equipments, Preparation of non chemicals and botanicals against disease management (Panchagavy, botanical extracts, Bijamrita, Panchapatra kashayam).

**Practical****Lecture outlines****Theory**

1. History of Plant Pathology with special reference to Indian work- contributions of Anton de Bary, Woronin, Oscar Brefeld, Marshal Ward, Millardet, Butler, Mundkur, Stakman, Dastur, Mehta, Sadasivan.
2. Terms and concepts used in plant Pathology - disease - disorder - pathogen - parasite - pathogenicity - pathogenesis - sign - symptom - syndrome - biotroph - hemibiotroph - perthotroph (necrotroph) - inoculum - inoculum potential - infection - incubation period - predisposition - hypersensitivity - epidemic - endemic and sporadic diseases.
3. Survival of plant pathogens - kinds of inoculum - primary and secondary inoculum - pattern of survival - infected host (main host, alternate host and collateral host) - saprophytic survival outside the host (soil, root inhabitants and rhizosphere colonizers) dormant spores or structures (seed borne, soil borne and on infected plant parts).
4. Dispersal of plant pathogens - active dispersal - seed, soil and plant parts, passive dispersal - air, water, members of animal kingdom (agents with examples), fungi and phanerogamic parasites.
5. Phenomenon of infection - process of infection - pre-penetration, penetration and post-penetration. Pre-penetration in fungi (spore germination, germ tube growth, formation of specialized structures like appressorium and rhizomorphs), bacteria and virus. Penetration - indirect penetration through wounds or natural openings like stomata, hydathodes and lenticels - direct penetration through plant surface (cutinized and non cutinized surfaces) by chemical or mechanical methods. Post penetration - colonization of the host.

6. Pathogenesis - role of enzymes, toxins, growth regulators and polysaccharides in plant diseases with examples. Enzymes - cutinases, pectinases, cellulases, lignases, proteases and lipases.
7. Toxins - pathotoxins, phytotoxins and vivotoxins - selective (host specific) and non-selective (host non-specific) toxins. Growth regulators - growth promoting substances (auxins, gibberellins and cytokinins) and growth inhibiting substances and polysaccharides.
8. Defense mechanisms in plants - pre-existing structural defense mechanisms - waxes, thick cuticle and epidermal cell wall - structure of natural openings, internal structural barriers – postinfectional structural defense - histological defense (cork layer, abscission layer, tyloses and gum deposition) and cellular defense (hyphal sheathing) structures.
9. Biochemical defense mechanisms - pre-existing biochemical defense mechanisms - inhibitors released by the plant in its environment (protocatechuic acid and catechol) and inhibitors present in the plant cell (phenolic compounds - chlorogenic acid) – post infectional defense mechanisms - phytoalexins, hypersensitive reaction - defense through plantibodies.
10. General principles of plant disease management - importance - general principles - avoidance of the pathogen (selection of pathogen free propagating material and seed, selection of field, choice of time of sowing and disease escaping varieties), - exclusion - plant quarantine and inspection, quarantine rules and regulations.
11. 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, seed rate and plant density, irrigation and drainage).
12. Physical methods of eradication- solarization and hot water treatment; Biological methods - role of biological control - mechanisms - competition, antibiosis, hyperparasitism, Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR).
13. Important fungal and bacterial biocontrol agents (*Trichoderma* spp, *Pseudomonas fluorescens*, *Bacillus subtilis* and *Ampelomyces quisqualis*) - Plant Growth Promoting Rhizobacteria (PGPR) against phytopathogens.
14. Contact and systemic fungicides against lower fungi, downy mildews, powdery mildews, rusts, smuts, coloured fungi, leaf spots and blights. Chemicals for soil drenching.
15. Mode of action and Formulations of fungicides, Antibiotics and their formulations.
16. Introduction to botanicals and other non-chemical preparations used in the disease management in organic and natural farming systems.

## Practical

1. Acquaintance with various laboratory equipment.
2. Preparation of culture media Potato Dextrose Agar (PDA) for fungi and Nutrient Agar (NA) for bacteria.
3. Isolation of fungal and bacterial pathogens.
4. Preservation of disease samples - dry and wet methods.
5. Demonstration of Koch's postulates for fungi.
6. Demonstration of Koch's postulates for bacteria.
7. Study of different groups of fungicides and antibiotics.
8. Preparation of fungicides - Bordeaux mixture, Bordeaux paste and cheshunt Compound.
9. Methods of application of fungicides - soil application.
10. Methods of application of fungicides - seed treatment.
11. Foliar application of fungicides - Calculation of fungicide spray concentrations.
12. Bioassay of fungicides - poisoned food technique, inhibition zone technique and slide germination technique.
13. Bio-control of plant pathogens - dual culture technique.
14. Incubation of *Trichoderma* in Farm yard manure for field application.
15. Pesticide equipment and their safe use.
16. Preparation of Panchagavya, Bijamrita, Panchapatra kashayam and other botanical extracts.

## References:

1. Agrios, G.N. 2005. *Plant Pathology*. Elsevier Academic Press, New York.
2. Chaube, H.S. and Ramji Singh. 2001. *Introductory Plant Pathology*. International Book Distribution Co., Lucknow. 136
3. Mehrotra, R.S. 1980. *Plant Pathology*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
4. Singh, R.S. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH Publ. Co.Pvt. Ltd., New Delhi.
5. Vidyasekharan, P. 1993. *Principles of Plant Pathology*. CBS Publishers and Distributors, New Delhi.

**Course outlines****Theory**

Symptoms, etiology, disease cycle and management of major diseases of following crops: Rice: blast, brown spot, Sheath rot, stem rot, narrow brown leaf spot, sheath blight, false smut, bacterial leaf blight, Bacterial leaf streak, tungro and Khaira; Wheat: rusts, loose smut, Karnal bunt, powdery mildew, Alternaria blight, and ear cockle; Sorghum: anthracnose, rust, ergot, grain mold, leaf blight, smuts, Charcoal rot, downy mildew, and Striga; Maize: stalk rots, downy mildew, leaf spots, banded leaf and sheath blight and blights; Bajra :downy mildew, ergot, rust and smut; Finger millet: Blast and leaf spot, smut and mosaic; Cotton: anthracnose, vascular wilts, leaf spots, rust and black arm; Sugarcane: red rot, smut, wilt, rust, ring spot, mosaic, grassy shoot, ratoon stunting and Pokkah Boeng; Tobacco: Damping off, frog eye leaf spot, Brown spot, black shank, black root rot and mosaic, leaf curl and Orobanchae; Groundnut: early and late leaf spots, Collor rot, pepper leaf spot, Sclerotium wilt, rust, PBNB, PSND and Kalahasti malady. Sesamum: Phyllody, Alternaria leaf spot, Powdery mildew, Macrophomina stem rot and bacterial leaf spot; Castor: Phytophthora blight, grey mold, root rot, bacterial leaf spot, seedling blight, rust and wilt; Sunflower: Downy mildew, powdery mildew head rot, rust, mosaic, necrosis, Sclerotinia stem rot and Alternaria blight; Safflower : wilt, Alternaria leaf spot, mosaic and rust; Mustard: Alternaria blight, white rust, downy mildew, powdery mildew and Sclerotinia stem rot; Pigeonpea: Phytophthora blight, wilt and sterility mosaic, bacterial leaf spot; Gram: rust, dry root rot, wilt, grey mould and Ascochyta blight; black & green gram: Cercospora, Corynospora leaf spot, bacterial leaf spot, angular black spot, anthracnose, powdery mildew, rust, web blight, yellow mosaic, leaf crinkle and cuscuta; Pea: downy mildew, powdery mildew and rust; Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot, rust and mosaic; Lentil: rust and wilt;

**Practical**

Identification and histopathological studies of selected diseases of field crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium;

**Note:** Students should submit 50 pressed and well-mounted specimens.

**Lecture outlines****Theory**

Study of etiology, symptoms, host-parasite relationship and specific management practices of the following diseases.

1. Rice diseases – blast, brown spot.
2. Rice diseases – Sheath rot, Stem rot, narrow brown leaf spot.
3. Rice diseases – sheath blight, False smut, Bacterial leaf blight.
4. Rice diseases – Bacterial leaf streak, Rice Tungro Disease, Khaira.

5. Wheat diseases – Black or stem rust, orange rust, yellow rust.
6. Wheat diseases - loose smut, Karnal bunt.
7. Wheat diseases – Powdery mildew, alternaria blight, Tundu disease.
8. Sorghum diseases – Anthracnose, rust, ergot, headmold, leaf blight.
9. Sorghum diseases - smuts, charcoal rot, downy mildew, *Striga*.
10. Maize diseases - Turicum leaf blight, post flowering stalk rots, charcoal rot.
11. Maize diseases - Banded leaf and sheath blight, downy mildew.
12. Bajra diseases – Downy mildew/green ear, rust, ergot, smut.
13. Ragi/Fingermillet diseases- blast, smut, mosaic.
14. Cotton diseases– Bacterial blight, Fusarium wilt, Verticillium wilt, root rot.
15. Cotton diseases – grey mildew, anthracnose, Alternaria leaf spot, Cercospora leaf spot, Helminthosporium leaf spot, rust.
16. Sugarcane diseases – red rot, whip smut, wilt, ring spot.
17. Sugarcane diseases – Grassy shoot, mosaic, ratoon stunting, rust, Pokah Boeng.
18. Tobacco diseases –black shank, Damping off, Frog eye spot, brown spot, black root rot.
19. Tobacco diseases – Mosaic, leaf curl, Orobanche.
20. Groundnut diseases – Collar rot, Tikka leaf spots, rust, pepper leaf spot, stem rot.
21. Groundnut diseases – Bud necrosis, Peanut stem necrosis disease, Kalahasti malady.
22. Sesamum diseases – Phyllody, Alternaria leaf spot, powdery mildew, charcoal rot, bacterial leaf spot.
23. Castor diseases – wilt, root rot, grey mold, bacterial leaf spot, seedling blight, rust.
24. Sunflower diseases – leaf blight, rust, powdery mildew, head rot, collar rot, downy mildew, mosaic, sunflower necrosis virus.
25. Safflower diseases – Alternaria leaf blight, wilt, rust, mosaic.
26. Mustard diseases – White rust, downy mildew, powdery mildew, Alternaria leaf spot, Sclerotinia stem rot.
27. Red gram diseases – Phytophthora blight, wilt, sterility mosaic and, bacterial leaf spot and stem canker.
28. Bengal gram diseases – wilt, rust, Ascochyta blight, stem and root rot, grey mold.
29. Black gram and Green gram diseases – Powdery mildew, rust, Cercospora leaf spot, Corynespora leaf spot, Angular black spot, Dry root rot, web blight.
30. Blackgram and Greengram diseases – Bacterial leaf spot, Yellow Mosaic virus, Leaf crinkle, Cuscuta.
31. Soybean diseases – Rhizoctonia blight, seed and seedling rot, rust, Soybean mosaic, Bacterial pustule; Pea diseases - downy mildew, powdery mildew and rust.
32. Cowpea diseases – Cowpea mosaic virus disease.; Lentil diseases - rust and wilt.

## PRACTICAL

Study of the symptoms, identification and histopathological studies of the following diseases.

1. Rice diseases
2. Wheat, Sorghum and Bajra diseases
3. Maize and Fingermillet diseases
4. Field visits for the diagnosis of crop diseases.
5. Sugarcane diseases
6. Tobacco diseases
- 6 Groundnut diseases
- 7 Field visits for the diagnosis of crop diseases.
- 8 Sunflower and Safflower diseases
- 9 Castor and sesamum diseases
- 10 Mustard diseases
- 11 Field visits for the diagnosis of crop diseases.
- 12 Cotton diseases
- 13 Redgram, greengram and blackgram diseases
- 14 Bengalgram, cowpea and soybean diseases
- 15&16 Field visits for the diagnosis of crop diseases

### References:

1. Rangaswami, Gand K.Mahadevan. 2001. *Diseases of crop plants in India*. Prentice Hall of India Pvt.Ltd, New Delhi.
2. Singh, R.S. 2005. *Plant Diseases*. Oxford & IBH Publications, New Delhi

**PATH 372                      DISEASES OF FIELD AND HORTICULTURAL CROPS                      2 (1+1)**  
**AND THEIR MANAGEMENT-II (HORTICULTURAL CROPS)**

### Course outlines

#### Theory

Symptoms, etiology, disease cycle and management of following diseases:

Citrus: canker, gummosis, felt, tristeza and greening; Mango: anthracnose, malformation, bacterial blight, powdery mildew, sooty mould, red rust and Loranthus; Guava: wilt and anthracnose; Papaya: foot rot, anthracnose, leaf curl and mosaic and powdery mildew; Ber: Powdery mildew; Sapota: Flat limb;;Banana: Panama wilt, bacterial wilt, Erwinia rhizome rot, Sigatoka, bunchy top, banana mosaic and banana bract mosaic; Pomegranate: Anthracnose and bacterial blight; Grape vine: downy mildew, Powdery mildew, anthracnose, alternaria leaf spot and rust; Apple: scab, powdery mildew, fire

blight and crown gall; Peach: leaf curl ; Strawberry: leaf spot Chillies: Damping off, anthracnose and fruit rot, wilt, powdery mildew, Choanephora blight cercospora leaf spot, bacterial leaf spot, mosaic complex and leaf curl; Brinjal: Phomopsis blight and fruit rot, bacterial wilt, Sclerotinia blight and little leaf; Okra:Cercospora leaf spot, powdery mildew and Yellow Vein Mosaic; Potato: early and late blight, black scurf, common scab,wart, black leg, brown rot, leaf roll, mosaics, potato spindle tuber; Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl, Septoria leaf spot, bacterial canker, root knot, Tomato spotted wilt and mosaic; Cruciferous vegetables: Club root, white rust, Downy mildew, powdery mildew, Alternaria leaf spot and black rot; Cucurbits: downy mildew, powdery mildew, Cercospora leaf spot, wilt and CMV; Betelvine: Root and stem rot, Sclerotial wilt,Fusarial wilt, Anthracnose; Onion and garlic: Smudge, smut,purple blotch, and Stemphylium blight; Beans: anthracnose, rust, yellow mosaic, Bean common mosaic virus and bacterial blight; Colocasia: Phytophthora blight; Coriander: stem gall; Coconut: Stem bleeding, Ganoderma wilt, bud rot, grey blight and tatipaka; Oilpalm: Bunchrot and spear rot ; Tea: blister blight; Coffee: rust; Turmeric: leaf spot, leaf blotch, rhizome rot; Ginger: rhizome rot/soft rot, leaf spot; Mulberry:powdery mildew; Rose: dieback, powdery mildew and black leaf spot; Marigold: Botrytis blight; Chrysanthemum: wilt, stunt, septoria blotch;Jasmine: rust; Crossandra : wilt

### Practical

Identification and histopathological studies of selected diseases of horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

**Note:** Students should submit 50 pressed and well-mounted specimens

### Lecture outlines

#### Theory

Study of etiology, symptoms, host-parasite relationship and specific management practices of the following diseases.

1. Citrus diseases - Citrus canker, gummosis (*Phytophthora* and *Diplodia*), felt, tristeza and greening.
2. Mango diseases:anthracnose, malformation, bacterial leaf spot, powdery mildew, sooty mold, red rust and Loranthus.
3. Guava, Papaya, Ber and Sapota diseases –Guava: wilt and anthracnose.Papaya: foot rot, anthracnose, leaf curl and mosaic and powdery mildew.Ber: Powdery mildew. Sapota: Flat limb.
4. Banana and Pomegranate diseases –Banana: Panama wilt, bacterial wilt, Erwinia rhizome rot, Sigatoka,bunchy top, banana mosaic and banana bract mosaic. Pomegranate: Anthracnose and bacterial blight.
5. Grapevine diseases – downy mildew, Powdery mildew, anthracnose, Alternaria leaf spot and rust.
6. Apple and Peach diseases –Apple: scab, powdery mildew, fire blight and crown gall Peach: leaf curl.

7. Chillies diseases - Damping off, die-back and fruit rot, Fusarium wilt, powdery mildew, Choanephora blight, Cercospora leaf spot, bacterial leaf spot, mosaic complex and leaf curl.
8. Brinjal and Okra diseases –Brinjal- Phomopsis blight and fruit rot, bacterial wilt and little leaf. Okra-Cercospora leaf spot, powdery mildew and Yellow Vein Mosaic.
9. Potato diseases - early and late blight, black scurf, common scab, wart, black leg, brown rot, leaf roll, mosaics, potato spindle tuber.
10. Tomato diseases - damping off, Ralstonia wilt, early blight, buck eye rot and leaf curl, Septoria leaf spot, bacterial canker, root knot, Tomato spotted wilt and mosaic.
11. Crucifers and Cucurbits diseases –Cruciferous vegetables- Club root, white rust, Downy mildew, powdery mildew, Alternaria leaf spot and black rot. Cucurbits: downy mildew, powdery mildew, Cercospora leaf spot, Erwinia wilt and CMV.
12. Betelvine, onion and garlic diseases –Betelvine: Phytophthora root and stem rot, Sclerotial wilt, Fusarial wilt, Anthracnose. Onion and garlic: Smudge, smut, purple blotch, and Stemphylium blight.
13. Beans, Colocasia and Coriander diseases –Beans- anthracnose, rust, Bean common mosaic virus and bacterial blight. Colocasia: Phytophthora blight. Coriander- stem gall.
14. Coconut and oil palm diseases –Coconut- Stem bleeding, Ganoderma wilt, bud rot, grey blight and Tatipaka disease. Oil palm- Bunch rot and spear rot. Tea- blister blight. Coffee- rust.
15. Turmeric, ginger and mulberry diseases –Turmeric- leaf spot, leaf blotch, rhizome rot. Ginger: rhizome rot/soft rot, leaf spot. Mulberry- powdery mildew.
16. Rose- dieback, powdery mildew and black leaf spot. Marigold: Botrytis blight. Chrysanthemum- wilt, stunt, Septoria blotch. Jasmine- rust. Crossandra - wilt

### **Practical**

Studies of symptoms, Identification and histopathological studies of the following diseases

1. Citrus diseases.
2. Mango diseases.
3. Ber, guava and sapota diseases.
4. Field visits for the diagnosis of crop diseases.
5. Papaya, banana and pomegranate diseases.
6. Grape and Apple diseases.
7. Chilli, brinjal and Bhendi diseases.
8. Field visits for the diagnosis of crop diseases.
9. Potato and tomato diseases.

10. Crucifers and cucurbits diseases.
11. Betelvine, Onion, Beans, Colocasia and Coriander diseases.
12. Field visits for the diagnosis of crop diseases.
13. Coconut and oilpalm diseases.
14. Tea, Coffee, Turmeric and Ginger diseases.
15. Mulberry, Rose, Jasmine and Chrysanthemum diseases.
16. Field visits for the diagnosis of crop diseases.

**Note:** Students should submit 50 pressed and well-mounted specimens.

### References

1. Rangaswami, G & Mahadevan, K.2001. *Diseases of crop plants in India*, Prentice Hall of India Pvt.Ltd, New Delhi.
2. Singh, R.S.2005. *Plant Diseases*. Oxford & IBH Publications, New Delhi
3. Pathak, V.N.2001. *Diseases of Fruit crops*. Oxford & IBH Publications, New Delhi
4. Singh, R.S.1999. *Diseases of Vegetable crops*. Oxford & IBH Publications, New Delhi
5. Chaube, H.S and V.S. Pundhir, 2012. *Crop Diseases & Their Management*. PHI Pvt.Ltd, New Delhi

**PATH 373**

## **PRINCIPLES OF INTEGRATED PEST AND DISEASE MANAGEMENT**

**2 (1+1)**

### Course outlines

#### Theory

Categories of insect pests and diseases, IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management. Survey, surveillance and forecasting of Insect pest and diseases. Development and validation of IPM module. Implementation and impact of IPM (IPM module for Insect pest and disease. Safety issues in pesticide uses. Political, social and legal implication of IPM. Case histories of important IPM programmes.

#### Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of Trichoderma,

Pseudomonas, Trichogramma, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agro-ecosystem) dynamics of a selected insect pest and diseases. Plan & assess preventive strategies (IPM module) and decision making. crop monitoring attacked by insect, pest and diseases . Awareness campaign at farmers fields.

## **Lecture outlines**

### **Theory**

#### **Plant Pathology**

1. Integrated disease management – Introduction, concept, Total system approach, Subsystem of IPM, IPM strategies, Integration of practices, Benefits and limitations.
2. Disease triangle, Disease pyramid, Factors affecting disease epidemics, Disease incidence-disease severity, Area under disease progress curve, Descriptive disease scales in important crops with examples. Survey and surveillance of plant diseases: Objectives, methodology and reporting results. Use of Remote sensing technology in Plant Pathology.
3. Plant disease forecasting – meaning – advantages, methods in forecasting, information needed for forecasting, examples of disease forecasting models.
4. Classification of fungicides based on chemical group and antibiotics with examples.
- 5& 6. Methods of disease control: Host plant resistance – advantages– Flor’s gene for gene hypothesis – types of resistance – vertical and horizontal resistance – mechanism of resistance. Cultural methods, mechanical methods and physical methods with examples. Biological control – Biocontrol organisms – mechanisms of biocontrol – examples- mass multiplication methods.
7. Integrated disease management in important crops : Rice , Groundnut, Cotton and Chillies
8. Integrated disease management in important crops – Mango, Banana, Citrus and Brinjal

#### **Entomology**

- 9 Economic importance of insect pests. Pest risk analysis - Calculation and dynamics of economic injury level and importance of Economic threshold level.
- 10 Methods of detection and diagnosis of insect pests – types of insect damage on crop plants based on the types of mouth parts ( biting and chewing, piercing and sucking, lacerating and sucking, siphoning and degenerate types)
- 11 Ecological management of crop environment - Ecological principles – importance of ecosystem concept – ecological niche – Agro ecosystem components and services in management of crop environment.
- 12 Introduction to conventional and botanical pesticides for the insect pests and disease management.

- 13 Survey & surveillance and forecasting of Insect pests, Case histories of IPM programmes – success stories. Development and validation of IPM modules for major crops – problem identification – Research and development of IPMs – Modules for major Agricultural and horticultural crops and validation.
- 14 Implementation and impact of IPM (IPM module for Insect pest) - IPM modules for major field crops (paddy, sugarcane, cotton, pulses and ground nut) major vegetables (brinjal, tomato, okra, cabbage and cauliflower), mango and coconut – Impact studies of IPM modules and constraints in implementation.
- 15 Political, social and legal implication of IPM - Safety issues in pesticide uses – legislative measures – Awareness about IPM, Farmers participation – Government support.
- 16 Safety issues in pesticide uses – Pesticide risk assessment, management and communication, use in agriculture. Environmental impact – health effects – residues, resurgence and resistance – effect on non target organisms – Strengths and weaknesses of pesticides.

### **Practicals:**

#### **Plant Pathology**

1. Identification of plant diseases based on symptoms and signs.
2. Laboratory methods used in the diagnosis of Plant diseases.
3. Methods of measurement of plant diseases, descriptive disease scales for important diseases. Plotting AUDP curves.
4. Methods to assess crop yield losses due to crop diseases with examples.
5. Identification of disease biocontrol agents – *Trichoderma*, *Pseudomonas*, *Bacillus* spp. – Laboratory isolation procedures.
6. Mass multiplication of biocontrol agents :*Trichoderma* and *Pseudomonas*.
7. Crop monitoring for assessment disease dynamics – Decision making.
8. IDM and non IDM methods – Cost benefit analysis – Case studies.

#### **Entomology**

- 9 Methods of diagnosis and detection of various insect pests.
- 10 Identification, nature of damage and dynamics of important insect pests and their management in different major crop ecosystems (paddy, maize, cotton, sugarcane, groundnut, castor, mango, citrus, coconut, brinjal and tomato).
- 11 Agro Eco System Analysis in major field crops (paddy and cotton).
- 12 Ecological engineering for rice.
- 13 Methods of assessment of insect pests population, damage and crop yield losses and calculation of cost benefit ratios (paddy/cotton).
- 14 Identification of natural biocontrol agents in different crop ecosystems.

- 15 Planning and assessment of insect pest preventive strategies (IPM module) and decision making.
- 16 Awareness campaign at farmer's fields.

**References:**

1. Dhaliwal, G. S. and Ramesh Arora 2001. *Integrated pest management: Concepts and approaches*, Kalyani Publishers Ludhiana.
2. Metcalf, R. L .and Luckman, W. H. 1982. *Introduction to insect pest management*. Wiley inter science publishing, New York.
3. Larry P Pedigo 1991. *Entomology and pest management*, Prentice Hall of India Private Ltd., New Delhi.
4. Venugopala Rao, N., Umamaheswari, T., Rajendraprasad, P, Naidu, V.G and Savithri, P. 2004. *Integrated Insect Pest Management*. Agrobios (India) Limited, Jodhpur.
5. Chaube, H.S. and Ramji Singh. 2001. *Introductory Plant Pathology*. International Book Distribution Co., Lucknow. 136.
6. Mehrotra, R.S. 1980. *Plant Pathology*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
7. Singh, R.S. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH Publ. Co.P. Ltd., New Delhi.
8. Vidyasekharan, P. 1993. *Principles of Plant Pathology*. CBS Publishers and Distributors, New Delhi.
9. Y. L. Nene and P.N. Thapliyal, 1993., *Fungicides in Plant Disease Control*. Oxford and IBH Publishing Co.

**Course outlines****Theory**

Horticulture-Its definition and branches, Importance and scope of horticulture, Horticultural and botanical classification, Climate and soil for horticultural crops, Plant propagation-methods (sexual & asexual), propagating structures; separation, division, grafting, budding, layering), High density planting; Use of rootstocks; Orchard establishment; (Principles & Layout) Principles and methods of training and pruning, Juvenility and flower bud differentiation; Unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy; Vegetable gardens & ornamental garden types and parts; Lawn making, Use of plant bio-regulators in horticulture, Irrigation methods in horticulture crops, Fertilizers application-methods.

**Practical**

Identification of garden tools, Identification of horticultural crops, Preparation of seed bed/nursery bed, Practice of sexual and asexual methods of propagation, Layout and planting of orchard plants, Training and pruning of fruit trees, Transplanting and care of vegetable seedlings, Making of herbaceous and shrubby borders, Preparation of potting mixture, potting and repotting, Fertilizer application in different crops, Visits to commercial nurseries/orchard.

**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 classification based on soil, climate and botanical classification.
4. Climate and soil for horticultural crops - Influence of environmental factors on horticultural crop production – Temperature, humidity, wind, rainfall and solar radiation – Influence of soil factors – Soil type, pH, EC.
5. Propagating structures- Plant propagation- Methods - Sexual and asexual – Propagation by cuttings – Definition of cutting – Stem cuttings – Leaf cuttings – Root cuttings.
6. Propagation by Layering - Types of layering (tip, simple, compound, mound, trench, air layering) - Natural modifications of layering (runners, suckers, stolon, offset)- Propagation by separation - Bulbs, corms; division (rhizome, stem tuber, tuberous roots).
7. Grafting, budding -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) - Graft incompatibility – Types – Translocated and localized incompatibility; Budding – Methods of budding – T-budding, inverted T-budding, patch budding and ring budding - Top working.

8. Principles of orchard establishment – Points to be kept in mind while selecting site for the establishment of orchards - Principles and steps in orchard establishment - Layout of orchards – Systems of planting - Square, rectangle, quincunx, hexagonal and contour systems of planting-their merits and demerits.
9. Principles and methods of training and pruning - Definition of training, objectives and training, principles and methods of training of fruit crops - Open centre, closed centre and modified leader systems their merits and demerits - Definition of pruning, objectives of pruning, principles and methods of pruning of fruit crops.
10. Juvenility and flower bud differentiation – 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) - Bearing habits of fruit trees.
11. Unfruitfulness, factors (physiological, phylogenical, management, parasitical, climatological) pollination - Self and Cross pollination, pollinizers and pollinators - Fertilization and parthenocarpy – Types.
12. Types of vegetables Gardens – Kitchen Garden, market garden, truck garden, vegetable forcing, garden for processing, seed production garden and floating garden. Ornamental garden types – Formal – Informal – Wild Garden – Parts/features of an ornamental garden.
13. Lawn making – Selection of Grass – Bermuda grass – Korean grass – Poa grass – Fescue grass – 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 – Maintenance of lawn – Mowing – Rolling – Sweeping –Scraping – Raking – Weeding – Irrigation – Top dressing with compost and fertilizers - Diseases and other problems – Fairy ring – Pale Yellow Laws.
14. Use of plant bio-regulators (PBR) in horticulture – Introduction – Applications of PBR in fruit crops.
15. Irrigation methods in horticulture crops - Different methods followed in horticultural crops (check basin, furrow, ring basin, basin, flood, pitcher, funnel, drip and sprinkler).
16. 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.

## Practical

1. Identification of garden tools.
2. Identification of horticultural crops.
3. Layout of different planting systems.
4. Layout of kitchen garden.
5. Preparation of nursery bed (raised and flat beds) and sowing of seeds.
6. Practice of different asexual methods by divisions.
7. Practice of different asexual methods by cuttings.
8. Practice of different asexual methods by grafting.
9. Practice of different asexual methods by budding.
10. Practice of different asexual methods by layering.
11. Training and pruning of fruit trees.
12. Transplanting and care of vegetable seedlings.
13. Making of herbaceous and shrubby borders.
14. Preparation of potting mixture, potting and repotting.
15. Fertilizer application in different crops.
16. Visits to commercial nurseries/orchard.

## References

1. Chadha, K.L. 2001. *Handbook of Horticulture*. ICAR, New Delhi.
2. Jitendra Singh, 2012. *Basic Horticulture*. Kalyani Publishers. New Delhi.
3. Randhawa, G.S. and Mukhopadhyaya, A. 1994. *Floriculture in India*. Allied Publishers Pvt. Ltd., New Delhi
4. Kumar, N. 1997. *Introduction to Horticulture*. Rajyalakshmi Publications, Nagorcoil, Tamilnadu.

**HORT 182**

**PRODUCTION TECHNOLOGY OF FRUITS  
AND PLANTATION CROPS**

**2 (1+1)**

## Course outlines

### Theory

Importance and scope of fruit and plantation crop industry in India; Production technologies for the cultivation of major fruits-Mango, Banana, Citrus, Grape, Guava & Litchi, Papaya, Apple, Pear, Peach, Minor fruits- Pineapple, Pomegranate, Jackfruit, Strawberry, Nut crops (Almond & Walnut), Plantation crops-Coconut, Areca nut, Cashew, Tea, Coffee & Rubber.

### Practical

Seed propagation, Scarification and stratification of seeds, Propagation methods for fruit and plantation crops including Micro-propagation, Description and identification

of fruit, Preparation of plant bio regulators and their uses, Pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchard.

## Lecture outlines

### Theory

1. Importance and scope of fruit crops - High density planting - Canopy management - Use of rootstocks in fruit crops.
2. Production technologies of Mango - Botanical name - Family – Origin – Introduction - Varieties – Climate – Soil- Propagation - Planting - Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests - Stem borer - Nut weevil -Fruit fly - Leaf webber - Diseases - Powdery mildew - Anthracnose - Sooty mould - Mango malformation - Physiological disorders-Fruit drop-Alternate bearing- Spongy tissue.
3. Production technology of Banana - Botanical name- Family – Origin - Importance- Varieties – Climate – Soil - Propagation- Planting – Manuring - Irrigation – Inter Cultivation practices – Harvesting – Yield – Pests - Rhizome weevil - Pseudo Stem weevil- diseases - Sigatoka leaf spot - Panama wilt - Rhizome rot - Bunchy top.
4. Production technology of Citrus - Botanical name – Family - Origin- Introduction - Varieties – Climate – Soil - Propagation - Planting - Manuring - Irrigation – Inter Cultivation – Harvesting – Yield – Pests -Butter fly - Fruit sucking moth - Citrus leaf miner - Diseases – Gummosis – Canker - Tristeza - Physiological disorders - Fruit drop – Granulation.
5. Production technology of Grape- Botanical name- Family- Origin- Introduction - Varieties – Climate – Soil - Propagation- Planting- Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests-Flea beetles – Mealy bug - Stem girdler Diseases- Powdery mildew - Downy Mildew – Anthracnose - Physiological disorders- Pink berries.
6. Production technology of Guava and Litchi - Botanical name- Family- Origin- Introduction - Varieties – Climate – Soil- Propagation - Planting- Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests of Guava - Tea mosquito bug - Mealybug - Diseases of Guava – Wilt.
7. Production technology of Papaya - Botanical name - Family- Origin- Introduction- Varieties – Climate – Soil – Propagation – Planting – Manuring - Irrigation – Inter Cultivation – Harvesting – Yield – Pests - Nematodes - diseases - Powdery mildew - Foot rot – Mosaic.
8. Production technology of Apple, Pear, Peach - Botanical name – Family – Origin – Importance – Varieties – Climate – Soil – Propagation - Planting- Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests of Apple - Woolly aphid, Codling moth - Pests of Peach - Fruit Fly - Diseases of Apple- Scab - Powdery mildew- Physiological disorder in apple - Bitterpit - Diseases of Pear- Fruit spot - Diseases of Peach- Leaf curl.

9. Production technology of Minor fruits- Pineapple, Pomegranate - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Pests of pineapple- Mealy bug -Pests of pomegranate- Butterfly -Fruit sucking moth - Diseases of pineapple - Leaf and fruit rot - Diseases of pomegranate - Anthracnose and bacterial leaf spot - Physiological disorders of pomegranate - Fruit cracking.
10. Production technology of Jackfruit, Strawberry, Nut crops (Almond & Walnut) - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield – Pests of Jackfruit - Spittle bug - Fruit borer – Diseases of Jackfruit - Rhizopus rot - Die back.
11. Plantation crops- Scope and Importance - Coconut – Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield – Processing – Pests of Coconut - Black headed caterpillar - Rhinoceros beetle - Red palm weevil diseases of Coconut – Ganoderma - Tatipaka - Drey blight.
12. Production technology of Arecanut - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – harvesting – Yield – Processing - Pests of Arecanut - Mite - Spindle bug Diseases of Arecanut - Mahali (Fruit rot)- Foot rot.
13. Production technology of Cashew - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield – Processing - Pests of Cashewnut - Stem borer - Tea mosquito bug - Diseases of Cashewnut - Die back or Pink disease – Anthracnose.
14. Production technology of Tea - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Processing- Pests of Tea - Tea mosquito bug- Red spider mite - Diseases of Tea - Algal leaf spot- Blister blight.
15. Production technology of Coffee - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Processing- Pests of Coffee -White borer - Red borer and Green scales – Diseases of Coffee - Rust- Die back -Berry blotch.
16. Production technology of Rubber - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Processing- Pests of Rubber - Scale insect - Mealy bug and mite - Diseases of Rubber - Birds eye spot - Pink disease.

### **Practical**

1. Seed propagation-Scarification and stratification of seeds.
2. Propagation methods for fruit crops.
3. Propagation methods for plantation crops.

4. Micro-propagation.
5. Description and identification of fruit crops.
6. Preparation of plant bio regulators and their uses.
7. Pests and diseases of Mango, Banana, Citrus.
8. Pests and diseases of Grape, Papaya, guava.
9. Pests and diseases of Apple, Pear, Peach.
10. Pests and diseases of Pineapple, Pomegranate, Jackfruit.
11. Pests and diseases of Coconut, Arecanut.
12. Pests and diseases of Cashew, Rubber.
13. Pests and diseases of Coffee and Tea.
14. Physiological disorders of fruit crops – Mango, Citrus, Grape.
15. Physiological disorders of the plantation crops.
16. Visit to commercial plantations/ fruit orchards.

### References

1. Bose, T.K. and Mitra, S.K. 1990. *Fruits – Tropical and Sub-tropical*. Naya Prakashan, Calcutta.
2. Chattopadhyaya, P. K. Year. *Text Book on Pomology (Fundamentals of Fruit Growing)*. Kalyani Publishers, Ludhiana.
3. Bijendra Singh. 2012. *Horticulture at a Glance*. Kalyani Publishers, Ludhiana
4. Parthasarathy, V. A., P.K.Chattopadhyay and Bose, T.K. 2006. *Plantation Crops*. Vol I and II. Parthasankar basu Naya Udyog, Kolkata.
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**HORT 281**

**PRODUCTION TECHNOLOGY  
FOR VEGETABLES AND SPICES**

**2 (1+1)**

### Course outlines

#### Theory

Importance of vegetables & spices in human nutrition and national economy, Tomato- origin, area, production, improved varieties and cultivation practices such as time of sowing, sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting, storage, physiological disorders, disease and pest control and seed production Brinjal & Chilli, Okra & Leafy vegetables, Cucurbits – Cucumber & Melons , Gourds - Ridge gourd, Bitter gourd, Bottle

gourd Snake gourd, Cole crops- Cabbage & Cauliflower, Peas & beans (Cluster bean, French bean. Dolichos), Root crops (carrot & radish), Tapioca & sweet potato, Perennial vegetables – drumstick & curry leaf, Bulb crops – onion & garlic, Black pepper, Cardamom, Ginger & turmeric, Coriander, Cumin & Fenugreek

### **Practical**

Identification of vegetables & spices crops and their seeds. Nursery raising, Direct seed sowing and transplanting, Study of morphological characters of different vegetables & spices, Fertilizers applications, Raising of nursery of vegetables & spices, Vegetables & spices seed extraction, Harvesting & preparation for market, Economics of vegetables and spices cultivation.

### **Lecture outlines**

#### **Theory**

1. Importance of vegetables and spices in human nutrition and national economy – Classification of vegetables - 1) Botanical 2) Based on Hardiness 3) Parts Used 4) Method of culture 5) Season.
2. Tomato- Botanical Name – Family – Origin – Area – Production- Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Physiological disorders - Disease and pest control and seed production.
3. Brinjal and Chilli - Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing - Sowing - Transplanting techniques - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Disease and pest control and seed production.
4. Okra and Leafy vegetables (Amaranthus and Gogu) - Botanical name – Family - Origin - area - Production - Improved varieties and cultivation practices such as time of sowing - Sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Disease and pest control and seed production.
5. Cucurbits – Flowering, sex expression, sex ratio - Cucumber, Ridge gourd, Bitter gourd, Bottle gourd- Botanical name – Family - Origin - Area - Production - improved varieties and cultivation practices such as time of sowing - Sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Physiological disorders - Disease and pest control and seed production.
6. Melons – Watermelon and Muskmelon - Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing - sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield – Production of seedless watermelons - Storage - Physiological disorders - Disease and pest control and seed production.
7. Cole crops- Cabbage and Cauliflower -Botanical name – Family - Origin - Area - production - Improved varieties and cultivation practices such as time of sowing

- sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield -Storage - Physiological disorders - Disease and pest control and seed production.
- 8. Peas and beans (Cluster bean, French bean, Dolichos) - Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of Sowing - sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield –Storage - Physiological disorders - Disease and pest control and seed production.
- 9. Root crops (Carrot and Radish) - Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing - Sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Physiological disorders (splitting, forking and cavity spot) - Disease and pest control and seed production.
- 10. Tapioca and Sweet potato - Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing - Sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Physiological disorders - Disease and pest control and seed production.
- 11. Perennial vegetables – Drumstick and Curry Leaf- Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing - Sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Physiological disorders - Disease and pest control and seed production.
- 12. Bulb crops – Onion and Garlic - Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing - Sowing - Planting distance - Fertilizer requirements - Irrigation - Weed management - Harvesting - Yield - Storage - Physiological disorders - Disease and pest control and seed production.
- 13. Black pepper - Botanical name – Family - Origin - Introduction - Varieties - Climate- Soil – Systems of cultivation -Ppropagation - Planting - Shade regulation - Training and pruning - Fertilizer requirements - Irrigation - Intercultural operations - Harvesting – Processing - Yield - Pests and diseases.
- 14. Cardamom - Botanical name – Family - Origin - Introduction - Varieties - Climate-soil –Systems of cultivation - Propagation - Planting - Shade regulation – Fertilizer requirement - Irrigation - Intercultural operations - Harvesting – Processing - Yield - Pests and diseases.
- 15. Ginger and Turmeric – Botanical name – Family - Origin - Introduction - Varieties - Climate- Soil – Systems of cultivation - Propagation - Planting - Mulching – Fertilizer requirement - Irrigation - Intercropping - intercultural operations - Harvesting – Processing - yield - Pests and diseases – Preservation of seed rhizomes.
- 16. Cinnamon - Coriander and Fenugreek- Botanical name – Family - Origin - Area - Production - Improved varieties and cultivation practices such as time of sowing

- sowing - Transplanting techniques - Fertilizer requirements - Irrigation - Intercultural operations - Harvesting - Pests and Diseases.

### **Practical**

1. Identification of vegetables and their seeds.
2. Identification of spices crops and their seeds.
3. Nursery raising techniques of vegetable crops.
4. Direct seed sowing and transplanting.
5. Study of morphological characters of different vegetables.
6. Study of morphological characters of different spices.
7. Physiological disorders of vegetable crops.
8. Intercultural operations in vegetable crops.
9. Fertilizers application methods.
10. Seed extraction methods in vegetables.
11. Seed extraction methods in spices.
12. Harvest indices and maturity standards of vegetable crops.
13. Harvesting and preparation for market.
14. Economics of vegetables and spices cultivation.
15. Visit to vegetable farmer fields.
16. Visit to vegetable markets to study marketing problems.

### **References**

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.
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6. Shanmugavelu, K.G., N. Kumar and K.V. Peter 2005. *Production Technology of Spices and Plantation Crops*. Agrobios (India), Jodhpur.

### **Course outlines**

#### **Theory**

Importance and scope of ornamental crops, 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, carnation, liliun and orchids under protected conditions and gladiolus & tuberose, chrysanthemum under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like asparagus, aloe, costus, periwinkle, isabgol and Aromatic plants like mint, lemongrass, citronella, Palmarosa, Ocimum, Geranium, Vetiver. Processing and value addition in ornamental crops and MAPs produce.

#### **Practical**

Identification of Ornamental plants, Identification of Medicinal and Aromatic Plants. Nursery bed preparation and seed sowing, Training and pruning of Ornamental plants, Planning and layout of garden, Bed preparation and planting of MAP, Protected structures – care and maintenance, Intercultural operations in flowers and MAP, Harvesting and post harvest handling of cut and loose flowers, Processing of MAP, Visit to commercial flower/MAP unit.

### **Lecture outlines**

#### **Theory**

1. Importance and scope of ornamental crops and landscaping - Landscape uses of trees, shrubs and climbers.
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 – Contract – Harmony- Vista – Style.
3. Production technology of cut flowers under protected conditions -Rose – Introduction- 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 management- Yield and rose bi-products.
4. Gerbera - Introduction- Origin and distribution- Classification- Species and varieties- Climate and soil requirements- Propagation- Land preparation- Planting- Manures and fertilizers- Cultural operations - Defoliation- Soil loosening- Shading- use of growth regulators- Physiological disorders- Harvesting- Post harvest management and yield.

5. Carnation - 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- Physiological disorders- Harvesting- Post harvest management and yield.
6. Liliiumand Orchids - Introduction- Origin and distribution- Classification- Species and varieties- Climate and soil requirements- Propagation- Land preparation- Planting- Manures and fertilizers- Cultural operations- Use of growth regulators- Physiological disorders- Harvesting- Post harvest management and yield.
7. Production technology of cut flowers under open conditions - Gladiolus and Tuberose- Introduction- Origin and distribution- Classification of varieties- Species and varieties- Climate and soil requirements- Propagation- Land preparation- Planting- Manures and fertilizers- Cultural operations- Use of growth regulators- Physiological disorders- Harvesting- Post harvest management and yield.
8. 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.
9. Loose flowers - Marigold and Jasmine under open conditions - Introduction- Origin and distribution- Species and varieties- F1 hybrids- Cimate 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. Medicinal plants – Scope and Importance – Production technology of Asparagus, Aloe, Costus - Botanical name – Family - Origin - Economic part - Introduction – Climate – Soil - Varieties – Propagation – Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield.
11. Periwinkle, Isabgol -Botanical name – Family - Origin - Economic part - Introduction – Climate – Soil - Varieties – Propagation – Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield.
12. Aromatic plants – Importance – Essential oil industry in India – Properties of essential oils – Production technology of Mint and Ocimum - Botanical name – Family - Origin - Economic part - Introduction – Climate – Soil - Varieties – Propagation – Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield.
13. Lemongrass, Citronella, Palmarosa - Botanical name – Family - Origin - Economic part - Introduction – Climate – Soil - Varieties – Propagation – Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield.
14. Geranium and Vettiver - Botanical name – Family - Origin - Economic part - Introduction – Climate – Soil - Varieties – Propagation – Planting - Manuring - Irrigation - Intercultural operations - Harvesting - Yield.
- 15&16. Processing and value addition in ornamental crops and MAPs produce – Dry flower making - Extraction methods of essential oils.

## Practical

1. Identification of ornamental plants.
2. Identification of Medicinal and Aromatic Plants.
3. Nursery bed preparation and flower seed sowing.
4. Training and pruning of roses.
5. Planning and layout of ornamental garden.
6. Bed preparation and planting of Medicinal and Aromatic Plants.
7. Protected structures – Care and maintenance.
8. Intercultural operations in flowers crops.
9. Intercultural operations in Medicinal and Aromatic plants.
10. Harvesting and post harvest handling of cut and loose flowers.
11. Floral preservatives to prolong vase-life of cut flowers.
12. Drying / dehydration techniques for flower drying.
13. Processing of Medicinal and Aromatic Plants.
14. Extraction of essential oils.
15. Visit to commercial flower unit.
16. Visit to commercial MAP unit.

## References

1. Bose, T.K. 1999. *Floriculture and Landscaping*. Naya Prakash, Kolkatta.
2. Bose, T.K. and Yadav, L.P. 1992. *Commercial Flowers*. Naya Prakash, Kolkatta.
3. Randhawa, G.S. and Mukhopadhyaya, A. 1994. *Floriculture in India*. Allied Publishers Pvt. Ltd., New Delhi
4. Chattopadhyay, S.K. 2007. *Commercial Floriculture*. Gene-Tech Books, New Delhi
5. Srivastava, H.C. 2014. *Medicinal and Aromatic Plants*. ICAR, New Delhi.
6. Kumar, N., Abdul Khader, J.B.M, Rangaswamy, P and Irulappan, I. 2004. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Crops*. Oxford and IBH publishing Co, New Delhi.

**HORT 381**

**POST-HARVEST MANAGEMENT AND  
VALUE ADDITION OF FRUITS AND VEGETABLES**

**2 (1+1)**

## Course outlines

### Theory

Importance 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 — physico-chemical and sensory, Visit to processing unit/ industry

### **Lecture outlines**

#### **Theory**

1. Scope and Importance of post harvest technology of fruits and vegetables- Extent and possible causes of post harvest losses- Causes of post harvest losses.
2. Pre-harvest factors affecting postharvest quality, maturity, ripening and shelf life of fruits and vegetables – Environmental factors (Temperature, Light, Rainfall, Wind, Relative humidity) – Cultural factors – (Rootstock, Variety, Mineral nutrients, growth regulators, Irrigation, pruning, thinning, girdling) – Maturity – Pest and diseases.
3. Changes occurring during ripening – Ripening definition- Climacteric and non-climacteric fruits – Metabolic changes - Maturation of seeds – Colour – Texture - Changes in carbohydrates- Changes in aromatic volatiles - Changes in organic acids – Fruit abscission – Changes in respiration rate – Development of surface waxes – Changes in tissue permeability.
4. Causes for deterioration of harvested fruits and Vegetables -Respiration and factors affecting respiration rate – Transpiration and factors affecting transpiration - Ethylene –Mechanical damage – Pest and Diseases.
5. Post harvest diseases and disorders - Heat, chilling and freezing injury.
6. Harvesting and field handling – Methods of harvesting – Post harvest handling – Pre-cooling - Sorting and grading – Disinfestation – Post harvest treatments (Waxing, Wrapping, de-greening, ripening).
7. Storage – Methods of storage – Traditional storages (In-situ, pit storage, high altitude, clamp storage, wind breaks, cellars, barns, Night ventilation, Evaporative cool storage ZECC) - Improved storage methods (Refrigerated storage, modified atmospheric storage, controlled atmospheric storage, hypobaric storage).

8. Value addition – Concept – Scope and importance of fruit preservation in India – Status of fruit preservation in India.
9. Principles and methods of preservation – Principles of preservation – Preservation methods – High temperature, low temperature, drying, filtration, chemicals, food additives, fermentation, carbonation, antibiotics, irradiation etc.
10. Intermediate moisture foods - Jam, jelly, marmalade – Problems in Jam making- important considerations and problems in Jelly making- Problems in marmalade making.
11. Preserve, candy – Concepts and Standards – Flow chart for manufacturing of preserve and candy – Problems in preservation of preserve and candied fruits – Glazed fruits/vegetables.
12. Fruit beverages –Fermented (Juices, Ready to serve, Nectar, cordial, Squash, crush, Syrup, Fruit Juice concentrate, Fruit Juice, Powder, Carbonated beverages) and non-fermented beverages (Wine, Champagne, Port, Sherry, Tokay, Muscat, Perry, Nira, Feni, Cider) – Preparation and preservation of unfermented fruit beverages.
13. Tomato processing - Concepts and Standards – Tomato juice – Tomato puree and paste – Tomato sauce/ketchup- Tomato chutney/pickle –Tomato cocktail – Tomato soup – Canned tomatoes.
14. Drying/dehydration of fruits and vegetables – Factors affect the rate of drying – Advantages of dehydration over sun drying – Process of drying/dehydration of fruits and vegetables – Spoilage of dried fruits and vegetables - Freezing – Methods of freezing.
15. Canning of fruits and vegetables – Selection of fruits and vegetable - Causes of spoilage of canned foods – Testing for defects - Containers for packing of canned products – Tin containers, glass containers.
16. Packaging of products - Definition – Properties of good packaging material – Different packaging materials for fresh fruits and vegetables for export – Cushioning materials – Purpose – Characteristics of cushioning material.

### **Practical**

1. Applications of different types of packaging containers for shelf life extension.
2. Effect of temperature on shelf life and quality of produce.
3. Demonstration of chilling and freezing injury in vegetables and fruits.
4. Extraction and preservation of pulps and juices.
5. Preparation of jam.
6. Preparation of jelly.
7. Preparation of RTS.
8. Preparation of nectar.
9. Preparation of squash.

10. Preparation of osmotically dried products.
11. Preparation of fruit bar and candy.
12. Preparation of tomato sauce.
13. Preparation of tomato ketchup.
14. Preparation of canned products.
15. Quality evaluation of products - (physic-chemical and sensory).
16. Visit to processing unit/ industry.

### **References**

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

**Course outlines****Theory**

Universal human aspirations: Happiness and prosperity; Human values and ethics: Concept, definition, significance and sources; Fundamental values: Right conduct, peace, truth, love and non-violence; Principles and Philosophy. Self Exploration. Self Awareness. Self Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

Ethics: professional, environmental, ICT; Sensitization towards others particularly senior citizens, developmentally challenged and gender.

Spirituality, positive attitude and scientific temper; Team work and volunteering; Rights and responsibilities; Road safety; Human relations and family harmony; Modern challenges and value conflict: Sensitization against drug abuse and other social evils; Developing personal code of conduct (SWOT Analysis); Management of anger and stress.

**Lecture outlines****Theory**

1. Universal human aspirations, happiness and prosperity
2. Human values and ethics - Concept, definition, significance and sources - Fundamental values - Right conduct, peace, truth, love and non-violence.
3. Principles and philosophy – Self exploration, self awareness, self satisfaction, decision making, motivation, sensitivity, success, selfless service.
4. Case study of ethical lives.
5. Positive spirit, body, mind and soul - Attachment and detachment.
6. Spirituality and spirituality quotient.
7. Examinations.
8. Ethics - Professional, environmental, ICT - Sensitization towards others particularly senior citizens, developmentally challenged and gender.
9. Positive attitude and scientific temper.
10. Team work and volunteering.
11. Rights and responsibilities.
12. Road safety.
13. Human relations and family harmony, modern challenges and value conflict.
14. Sensitization against drug abuse and other social evils.
15. Developing personal code of conduct (SWOT/SWOC/SNAC Analysis).
16. Management of anger and stress.

## References

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2. Mathur SS. 2010. *Education for Values, Environment and Human Rights*. RSA International.
3. Sharma RA. 2011. *Human Values and Education – Axiology, Incultation and Research*. R. Lall Book Depot.
4. Sharma RP and Sharma M. 2011. *Value Education and Professional Ethics*. Kanishka Publishers.
5. Srivastava S. 2011. *Human Values and Professional Ethics*. S K Kataria and Sons.
6. Srivastava S. 2011. *Environmental Science*. S K Kataria & Sons.
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8. R.S. Nagarajan. *Text Book on Professional Ethics & Human Values*.
9. D.R. Kiran. *Professional Ethics & Human Values*
10. Veerendra Kumar. *Human Values and Professional Ethics*.
11. M.Govindarajan. *Engineering Ethics*.

**AEXT 191**

**RURAL SOCIOLOGY AND  
EDUCATIONAL PSYCHOLOGY**

**2 (1+1)**

### Course outlines

#### Theory

Sociology and Rural Sociology: Meaning, definition, scope, its significance in agriculture extension, Importance of Rural Sociology in Agricultural Extension and their Interrelationship. Indian Rural Society - Characteristics, Differences and Relationship between Rural and Urban Society, Social Group(s) – Meaning, Definition, Classification, Factors to be considered in formation of groups; Role of Social Groups in Agricultural Extension - Social Stratification – Meaning, Definition, Bases and Forms of Social Stratification, Characteristics and Differences between Class System and Caste System. Different Cultural Concepts viz., Culture, Tradition, Customs, Folkways, Mores, Taboos, Ritual: Definition, Meaning, Concept and Examples and their Role in Extension Education. Social Values: Meaning, Definition and Types; Social Control - Meaning, Definition, Need of social control and means of social control; and Attitudes - Types and their Role in Agricultural Extension. Social Institution – Types – Family, Education, Religious, Economic (Co - Operative Society) & Political (Panchayat). Characteristics, Functions and their importance / role in Agricultural Extension. Social Change - Meaning, definition, Nature of Social change, Dimensions of social change and factors of social change & Development: Psychology and Educational Psychology - Meaning, Definition, Scope and its Importance in Agricultural Extension. Behavior: Cognitive, affective, psychomotor domain, Intelligence - Meaning, Types, Factors and Importance in Agricultural Extension.

Perception, Emotions, Frustration - Meaning, Types, Factors and Importance in Agricultural Extension, Motivation - Meaning, Types of Motives, Theories of Motivation and Importance of Motivation in Agricultural Extension. Personality - Meaning, Definition, Types, Factors influencing Personality and Importance in Agricultural Extension. Teaching, Learning, Learning Experience, Learning Situation - Meaning and Definition, Elements of Learning Situation and its Characteristics. Principles of Learning, their implications in Teaching and Steps in Extension Teaching.

### **Practical**

Visit to Village to study the Characteristics of Rural Society and rural stratification; Social Groups, Village Institutions – School / Co - Operative Society / Gram Panchayat; Social Organizations - Youth Club / Milk Co - Operative Centre / Water User Association; Visit to a Village to list out the Folkways, Mores, Taboos, Ritual, Customs, Tradition, Culture, Etiquette, Social Values, Simulated Exercises for Positive and Negative Emotions of Farmers in a Village. Administering Psychological Tests to assess Personality Types of Human Beings. Experiment: 1. Eysenk personality inventory; 2. Edward's personality inventory. Types of Intelligence and Frustrations among Farmers, Creating a Learning Situation under Village Conditions - Organizing a Extension Talk for Farmers in the Village / Conduct of a Method Demonstration in Village Situation

### **Lecture outlines**

#### **Theory**

1. Sociology and Rural Sociology - Meaning, definition, scope, its significance in Agricultural Extension - Importance of Rural Sociology in Agricultural Extension and their interrelationship.
2. Indian rural society - Characteristics, differences and relationship between rural and urban society.
3. Social group(s) – Meaning, definition, classification, factors to be considered in formation of groups - Role of social groups in Agricultural Extension.
4. Social Stratification – Meaning, definition, bases and forms of social stratification, characteristics and differences between class system and caste system.
5. Different cultural concepts - Culture, tradition, customs, folkways, mores, taboos, ritual - Definition, meaning, concept and examples and their role in Agricultural Extension.
6. Social values - Meaning, definition and types; social control - Meaning, definition, need of social control and means of social control and attitudes - Types and their role in Agricultural Extension.
7. Social institution – Types – Family, education, religious, economic (Co-operative society) & political (Panchayat) - Characteristics, functions and their importance/ role in Agricultural Extension.
8. Social change - Meaning, definition, nature of social change, dimensions of social change and factors of social change & development.

9. Psychology and educational psychology - Meaning, definition, scope and its importance in Agricultural Extension – Behavior - Cognitive, affective and psychomotor domains.
10. Intelligence - Meaning, types, factors and importance in Agricultural Extension.
11. Perception - Meaning, types, factors and importance in Agricultural Extension.
12. Emotions and frustration - Meaning, types, factors and importance in Agricultural Extension.
13. Personality - Meaning, definition, types, factors influencing personality and importance in Agricultural Extension.
14. Motivation - Meaning, types of motives, theories of motivation and importance of motivation in Agricultural Extension.
15. Teaching, learning, learning experience, learning situation - Meaning and definition, elements of learning situation and its characteristics.
16. Principles of learning, their implications in teaching and steps in extension teaching.

### **Practical**

1. Visit to village to study the characteristics of rural society and rural stratification.
2. Visit to village to study the social groups.
3. Visit to village to study the village institution – School
4. Visit to village to study the village institution – Co operative society/ Bank.
5. Visit to village to study the village institution – Gram Panchayat.
6. Visit to village to study the social organization - Youth Club/ Rytu Mitra group.
7. Visit to village to study the social organization - Milk Co-operative centre/ Dairy unit.
8. Visit to village to study the social organization - Water User Association/ Self Help Group.
- 9&10 Visit to a village to list out the customs - Folkways, mores, taboos, rituals and social values - Simulated exercises on perception of students.
11. Simulated exercises for positive and negative emotions of students.
12. Nature of learners behavior in motivation.
- 13.&14. Administering psychological tests to assess personality types of human beings.  
Experiment: 1. Eysenk personality inventory Administering psychological tests to assess personality types of human beings. 2. Edward's personality inventory.
15. To study the types of intelligence among students.
16. Creating a learning situation under village conditions with a selected technology.

## References

1. Adivi Reddy, A. 2006. *Extension Education*. Sree Lakshmi Press, Bapatla
2. Chitamber, J. B. 1997. *Introductory Rural Sociology*. Wiley Eastern Limited, New Delhi
3. Daivadeenam, P. 2006. *Educational Psychology in Agriculture*. Agrotech Publishing Academy, Udaipur
4. Mangal, S. K. 2000. *Educational Psychology*. Prakash Brothers, Ludhiana.
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6. VidyaBhushan and Sach Dev. D. R. 1998. *An Introduction to Rural Sociology*. Kitab Mahal Agencies Allahabad.

**AEXT 291**

**FUNDAMENTALS OF AGRICULTURAL EXTENSION**

**3 (2+1)**

### Course outlines

#### Theory

Education: Meaning, definition & Types - Formal, Non - Formal and Informal Education; Extension Education - meaning, definition, Concepts, Characteristics 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, Sevagram, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, T & V System, KVK, IVLP, ORP, ND, NATP, ATMA, SREP,ATIC, NAIP, NFSM, RKVY etc.). New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc.

Community Development - meaning, definition, concept & principles, Philology of C.D. Rural Development: meaning, Definitions, concept, Characteristics, Objectives, Importance and Problems in Rural Development: various rural development programmes launched by Govt. of India - National Extension Service (NES). Panchayat Raj Systems / Democratic Decentralization and Panchayat Raj – Need, Three Tiers of Panchayat Raj System - Powers, Functions and Organization Set Up; Mandal System in Andhra Pradesh. Social Justice & Poverty Alleviation Programmes - ITDA, IWDP, NREP, IRDP, JRY, SGRY, SGSY, MGNREGP Women Development Programmes - ICDS, DWCRA, RMK, MSY,IKP, Participatory Rural Appraisal (PRA), Rural Leadership: Meaning, Definition and concept, types of leaders in rural context, Roles of Leaders, different Methods in Selection of a Leader, Training of Leaders - Lay and Professional Leaders, Advantages and Limitations in using Local Leaders in Agricultural Extension; extension administration:

meaning, definition and concept, principles and functions. Monitoring and evaluation - Meaning, definition, concept, Objectives, Types and Importance. and monitoring and evaluation of extension programmes; transfer of technology: concept and models, capacity building of extension personnel and Farmers- Training Meaning , definition, Types of Training - Pre Service Training, In - Service, Orientation, Induction Training, Refresher Training and Training for Professional Qualification; Training of Farmers, Farmwomen and Rural Youth - Farmers' Training Centre (FTC): Objectives - Trainings Organized; District Agricultural Advisory and Transfer of Technology Centre (DAATTC) - Objectives.extension teaching methods: meaning, classification, individual, group and mass contact methods, media mix strategies; and communication: meaning and definition; Functions of Communication, models - Aristotle, Shannon Weaver, Berlo, Schramm, J. P. Leagans, Rogers and Shoemaker, Litterer, Westley Macleans and barriers to communication. Agriculture journalism - Meaning – Scope Importance Characteristics of News Factors determining the News Value - Types of News and Sources of News; Diffusion and Adoption of innovation: Meaning, Definition, Concepts and process and Stages & Models of Adoption Process - Five (5) and Seven (7) Stage Models; Attributes of Innovation - Relative Advantage, Compatibility, Complexity, Trialability - Observability and Predictability, Innovation - Decision Process - Meaning - Stages (Knowledge, Persuasion, Decision, Implementation and Confirmation); Concepts: Dissonance – Rejection: Active Rejection and Passive Rejection; Discontinuance - Replacement and Disenchantment Discontinuance - Over Adoption - Rate of Adoption and Innovativeness; Adopter Categories and their Characteristics; Factors influencing Adoption Process Social, Personal and Situational.

### **Practical**

To study and familiarize university extension system. Group discussion – Simulated Exercise; Handling and use of audio visual equipments such as public address equipment (PAE) system, Still camera, digital camera and; Audio-visual Aids - meaning, importance and classification. Selection, planning, preparation, evaluation, presentation and use of Audio -visual aids. - Posters & Charts, Liquid Crystal Display (LCD) projector, Power Point Slides, ICT Tools - Interactive white board and Digital / Electronic podium, Text messages, Voice Mail, Interactive Video recording (IVR) and New Applications (Apps) for Transfer of Technology in Agriculture, Planning and preparation of extension literature – leaflet, folder, pamphlet, booklet with different DTP softwares. A visit to village to understand the problems being encountered by the villagers / farmers by administering the PRA techniques and understanding their applications in Village Development Planning; Visit to Krishi Vigyan Kendra (KVK), Farmers' Training Centre, (FTC), District Agricultural Advisory and Transfer of Technology Centre (DAATTC): Visit to study organization and functioning of DRDA, DWMA, ATMA, JDA Office and other development departments at district level; visit to NGO and learning from their experience in rural development; Writing for Print media – News Stories and Success Stories; Visit to community radio and television studio for understanding the process of programme production. Writing for electronic media. Developing script for radio and television.

## Lecture Outlines

### Theory

1. a) Education - Meaning, definition and Types – Formal, non-formal and informal education.  
b) Extension Education – Meaning, definition, concepts - Characteristics, scope and process.
2. Objectives and principles of extension education.
3. Extension programme planning – Meaning, process, principles.
4. Extension programme planning – Steps in programme development.
5. Extension systems in India.
6. Extension efforts in pre-independence era – Sriniketan, Marthandam, Sevagram, Firka Development Scheme, Gurgaon Experiment, etc.
7. Extension efforts in post-independence era - Etawah pilot project, Nilokheri experiment etc.
8. Extension/Agriculture development programme launched by ICAR/Govt. of India – IADP, IAAP and HYVP.
9. Extension / Agriculture development programme launched by ICAR / Govt. of India – SFDA, MFAL and T & V System.
10. a) Extension / Agriculture development programme launched by ICAR / Govt. of India, KVK, ORP and ND.  
b) IVLP.
11. a) Extension / Agriculture development programmes launched by ICAR / Govt. of India – NATP, ATMA, SREP, ATIC.  
b) NAIP.
12. New trends in agriculture extension – Privatization extension and cyber extension / e-extension.
13. New trends in agriculture extension – Market led extension, farmer-led extension, expert systems, etc.
14. Community development – Meaning, definition, concept and principles - Philology of C.D.
15. Rural development - Meaning, definitions, concept, characteristics, objectives, importance and problems in rural development.
16. Rural development launched by Govt. of India – National Extension Service (NES), Panchayat Raj Systems/ Democratic Decentralization and Panchayat Raj – Need.
17. Rural development launched by Govt. of India – Three tiers of Panchayat Raj system – Powers, functions and organization set up -Mandal system in Andhra Pradesh.
18. Social justice and poverty alleviation programmes – ITDA, IWDP and NERP.

19. Social justice and poverty alleviation programmes – IRDP, JRY, SGRY, SGSY and MGNREGP.
20. Women development programmes – ICDS, DW CRA, RMK, MSY, ANTWA and IKP.
21. Participatory Rural Appraisal (PRA)
22. Rural leadership - Meaning, definition and concept, types of leaders in rural context, roles of leaders and different methods in selection of a leader.
23. Training of leaders – Lay and professional leaders, advantages and limitations in using local leaders in Agricultural Extension.
24. Extension administration - Meaning, definition and concept, principles and functions - Monitoring and evaluation – Meaning, definition and concept, objectives - Types and importance and monitoring and evaluation of extension programmes.
25. Transfer of technology - Concept and models and capacity building of extension personnel farmers – Training – Meaning, definition, types of training – Pre-Service training - In-service, orientation, induction training, refresher training and training for professional qualification.
26. Training of farmers, farm women and rural youth – Farmers’ Training Centre (FTC) - Objectives – Training organized - District Agricultural Advisory and Transfer of Technology Centre (DAATTC) – Objectives.
27. Extension teaching methods - Meaning, classification, individual, group and mass contact methods, media mix strategies and communication - Meaning and definition
28. Functions of communication, models – Aristotle, Shannon, Weaver, Berlo, Schramm, J.P. Leagans, Rogers and Shoemaker, Litterer, Westley – Macleans and barriers to communication.
29. Agriculture journalism – Meaning – Scope – Importance - Characteristics of News – Factors determining the News value – Types of News and sources of News.
30. Diffusion and adoption of innovation - Meaning, definition, concepts and process and stages and Models of adoption process – Five (5) and Seven (7) stage models - Attributes of innovation – Relative advantage, compatibility, complexity, trialability – observability and predictability.
31. Innovation – Decision process – Meaning – Stages (Knowledge, persuasion, decision, implementation and confirmation) - Decision process – Meaning – Stages (Knowledge, persuasion, decision, implementation and confirmation) - Concepts - Dissonance – Rejection – Active rejection and passive rejection - Discontinuance – Replacement and disenchantment discontinuance – Over adoption – Rate of adoption and innovativeness.
32. Adopter categories and their characteristics - Factors influencing adoption process – Social, personal and situational.

## Practical

1. Audio-visual aids – Meaning, importance and classification - Selection, planning, preparation, evaluation, presentation and use of audio-visual aids – Charts.
2. Selection, planning, preparation, evaluation, presentation and use of audio-visual aids – Charts, posters, flip charts, flash cards, plannel graphs.
3. Selection, planning, preparation, evaluation, presentation and use of audio-visual aids – Power point slides.
4. Planning and preparation of extension literature – Leaflet, folder, pamphlet, booklet, news stories and success stories.
5. Handling and use of audio visual equipments such as public address equipment (PAE) system and still camera and digital camera and Liquid Crystal Display (LCD) Projector.
6. Group discussion – Simulated exercise.
7. Visit to a village to study on going rural development and agricultural developmental programmes.
8. To study and familiarize university extension system.
9. Visit to KVK.
10. Visit to Farmers' Training Centre (FTC).
11. Visit to District Agricultural Advisory and Transfer of Technology Centre (DAATTC).
12. Visit to study organization and functioning of DRDA, DWMA, ATMA, JDA Office and other development departments at district level.
13. Visit to a village to exercise PRA techniques.
14. Visit to community radio and television studio for understanding the process of programme production, Script writing.
15. Developing script for radio.
16. Developing script for television.

## References

1. Adivi Reddy, A. 2006. *Extension Eduation*. Sree Lakshmi Press, Bapatla.
2. Dahama, O.P. and Bhatnagar, O.P. 1999. *Extension and Communication for Development*. Oxford & IBH Private Limited, New Delhi/Mumbai.
3. Ganesh, R., Mohammad Iqbal and Ananda Raja. 2003. *Reaching the Unreached – Basics of Extension Education*. Associate Publishing Company, New Delhi.
4. Jalihal, K.A. and Veerabhadraiah, V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publishing House, New Delhi.
5. Ray, G.L. 2006. *Extension Communication and Management*. NayaProkash/Kalyani Publishers, Kalkatta/Ludhiana.

6. Rayudu, C.S. 1997. *Communication*. Himalaya Publishing House, New Delhi.
7. Rogers, E.M. 2003. *Diffusion of Innovation*. Free Press, New Delhi.
8. Soma Sundaram, T. 1977. *Producing Agricultural Information Materials*. Kansas State University, USA and APAU, Hyderabad.
9. Yella Reddy, N. 1998. *Audio-Visual Aids for Teaching, Training and Extension*. Haritha Publishing House, Hyderabad.
10. Vasantha R and Kiran. 2012 *Extension Education - New Horizons* – Kalyani Publishers.
11. Sagar Mondal and G.L. Ray. 2007. *Text book of Rural Development*. Kalyani Publishers, Kolkata/Ludhiana.
12. Ray, G.L. and Mondal S. 2005. *Journalism*. Kalyani Publishers, Kalkatta/Ludhiana
13. Jana, B.L. and Mitra. 2010. *Farm Journalism*. Agrotech Publishing Academy, Udaipur
14. Anandaraja N , Chandrakandan K and Ramasubramaniam. 2008. *Extension of Technologies from Labs to Lands*. New India Publishing Agency, New Delhi

**AEXT 292**

**ENTREPRENEURSHIP DEVELOPMENT  
AND BUSINESS COMMUNICATION**

**2 (1+1)**

**Course outlines**

**Theory**

Concept of Entrepreneur, Entrepreneurship, Distinction between an Entrepreneur and a Manager ; Management – Levels & Functions of Management - planning- Organizing -Directing – motivation – ordering – leading – supervision-Communication and control; Characteristics of Entrepreneurs; Opportunities for entrepreneurship and rural entrepreneurship. Types of Entrepreneurs, Functions of Entrepreneurship, Agri – Entrepreneurship - Concept, Need and Scope. Assessing overall business environment in Indian economy; Globalization and the emerging business entrepreneurial environment: Entrepreneurship Development Programmes (EDPs) – Objectives, Phases, Problems of EDPs, Entrepreneurial behavior and Role of Achievement Motivation, Factors Affecting Entrepreneurship Development; Generation, Incubation and Commercialization of Business Ideas. Environment scanning and opportunity identification, Researching / Managing Competition - Ways to define possible Competitors; Globalization and the emerging business entrepreneurial environment; Role of ED in economic development of a country- Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs SWOT Analysis - Concept, Meaning and Advantages. Government Policies, Incentives, Programmes and Schemes for Entrepreneurship Development; Export and Import Policies relevant to Indian Agriculture Sector. Institutional Support - Financial Institutions and other agencies in entrepreneurship development. Venture capital (VC), contract farming (CF) and joint ventures (JV), Public-private partnerships (PPP); Overview of agricultural Input industry – Seed, Fertilizer, Pesticides, Farm Machinery, Agricultural

Food Processing Industry; Steps in establishment of MSME Enterprise - Planning of an enterprise, Project identification, Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution; Project Planning, Formulation and Project Report - Meaning - Importance - Components and Preparation; Supply Chain Management - Meaning, Advantages, Stages and Process and Total quality Management; Definition of business; Stakeholders in business; Stages of Indian business; Importance of agribusiness in Indian economy; Business Communication for Public Relation , Advertisement and crisis communication. Social responsibility of business. Morals and ethics in enterprise management Assessment of Entrepreneurship skills, Business Leadership Skills; Communication Skills for entrepreneurship development, Developing organizational skill, Managerial skills, Problem solving skill and Time management skills.

### **Practical**

Field Visits to study any one Agri - based industries / business – Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, Constraints in setting up of agro based industries; Formulation of project feasibility reports; industrial and agribusiness houses; Characteristics of Successful Entrepreneurs, Characteristics of Successful Agripreneurs, any one of the Local Financial Institutions to study the MSME Policies, Visit to Entrepreneurial Development Institute to study the Process of Entrepreneurship Development, Local Public - Private Enterprises to study the Enterprise Establishment and Management Process as well as Assessing entrepreneurial potential problem solving ability, managerial skills and achievement motivation, exercise in Creativity, time audit, preparation of business plan and proposal writing; Carrying out the SWOT Analysis of nearby Successful Enterprises. Visit to nearest Agri - Clinic and Agri - Business Centre's, if any.

### **Lecture outlines**

#### **Theory**

1. Concept of entrepreneur, entrepreneurship - Distinction between an entrepreneur and a manager - Management - Management functions – Planning - Organizing - Directing - Motivation - Ordering - Leading – Supervision - Communication and Control.
2. Characteristics of entrepreneurs - Opportunities for entrepreneurship and rural entrepreneurship - Types of entrepreneurs and functions of entrepreneurship.
3. Agri – entrepreneurship - Concept, need and scope - Assessing overall business environment in Indian economy and globalization and the emerging business entrepreneurial environment.
4. Entrepreneurship development programmes (EDPs) – Objectives, phases, problems of EDPs - Entrepreneurial behavior and role of achievement - Motivation, factors affecting entrepreneurship development.

5. Generation, incubation and commercialization of business ideas - Environment scanning and opportunity identification - Researching/ Managing competition - Ways to define possible Competitors.
6. Globalization and the emerging business entrepreneurial environment - Role of ED in economic development of a country - Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs.
7. SWOT Analysis - Concept, meaning and advantages.
8. Government policies, incentives, programmes and schemes for entrepreneurship development - Export and import policies relevant to Indian Agriculture sector.
9. Institutional support - Financial Institutions and other agencies in entrepreneurship development
10. Venture capital (VC), contract farming (CF) and joint ventures (JV) - Public-private partnerships (PPP).
11. Overview of agricultural input industry – Seed, fertilizer, pesticides, farm machinery and agricultural food processing industry.
12. Steps in establishment of MSME Enterprise - Planning of an enterprise - Project identification - Selection of the product/ services - Selection of form of ownership - Registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.
13. Project planning - Formulation and project report - Meaning - Importance - Components and preparation.
14. Supply chain management - Meaning, advantages, stages and process and total quality management.
15. Marketing management - Market types - Marketing assistance - Market strategies - Definition of business - Stakeholders in business - Stages of Indian business - Importance of agribusiness in Indian economy -Social responsibility of business - Morals and ethics in enterprise management.
16. Assessment of entrepreneurship skills - Business leadership skills - Communication skills for entrepreneurship development - Developing organizational skill - Developing managerial skills - Problem solving skill and time management skills.

### **Practical**

- 1 Field visits to study any one Agri - based industries/ business – Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis.
- 2 Field visits to study the constraints in setting up of agro based industries - Formulation of project feasibility reports and industrial and agri-business houses.
- 3 Field visits to study the formulation of project feasibility reports.
- 4 Field visits to study the industrial and agri-business houses.
- 5 Field visits to study the characteristics of successful entrepreneurs.

- 6 Field visits to study the any one of the Local Financial Institutions to study the MSME Policies.
- 7 Field visits to study the Entrepreneurial Development Institute to study the Process of Entrepreneurship Development.
- 8 Field visits to the local Public - Private Enterprises to study the Enterprise Establishment and Management Process.
- 9 Field visit to the local Public - Private Enterprises to study the Assessing entrepreneurial potential problem solving ability.
- 10 Field visits to the local Public - Private Enterprises to study the managerial skills and achievement motivation.
- 11 Practicing exercise in creativity and time audit.
- 12 Practicing exercise in preparation of business plan and proposal writing.
- 13 Visit to nearest Agri - Clinic and Agri - Business Centre's if any.
- 14 Power Point Presentation of Assignments - Session I
- 15 Power Point Presentation of Assignments - Session II
- 16 Power Point Presentation of Assignments - Session III

### References

- 1 Anil Kumar, S., Poornima, S. C., Mini, K., Abraham and Jayashree, K. 2003. *Entrepreneurship Development*. New Age International Publishers, New Delhi
- 2 Bhaskaran, S. 2014. *Entrepreneurship Development & Management*. Aman Publishing House, Meerut
- 3 Gupta, C.B. 2001. *Management: Theory and Practice*. Sultan Chand and Sons, New Delhi
- 4 Indu Grover 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Publishing Academy, Udaipur
- 5 Khanka, S.S. 1999. *Entrepreneurship Development*. S. Chand and Co., New Delhi
- 6 Mary Coulter 2008. *Entrepreneurship in Action*. Prentice Hall of India Pvt. Ltd., New Delhi
- 7 Mohanty, S.K. 2009. *Fundamentals of Entrepreneurship*. Prentice Hall of India Pvt. Ltd., New Delhi
- 8 Prasad, R. 2003. *Entrepreneurship - Concepts and Cases*. I C F A I Publications, Hyderabad
- 9 Sagar Mondal and Ray, G. L. 2003. *Text Book of Entrepreneurship and Rural Development*. Kalyani Publishers, Ludhiana
- 10 Singh, D. 1995. *Effective Managerial Leadership*. Deep and Deep Publications, New Delhi
- 11 Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publishing House, New Delhi
- 12 Vasanta Desai. 2000. *Dynamics of Entrepreneurial Development and Management*. Himalaya Publishing House, New Delhi

**Course outlines****Theory**

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; Voice modulation basics and their usage for meaningful impact on people; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, Extempore, impromptu and Prepared presentations, public speaking; Group discussion. Organizing seminars and conferences. Human Behaviour – Domains and components of Behaviour; Personality and Personality Development – Meaning, Scope, Importance, Factors influencing Personality; Trait and Type Approaches; Personality Theories; Importance of Wants, Desires, Needs, Drives, Motives, Aspirations, Interests, Objectives and Goals in Personality development. Transactional Analysis - Importance, Methods and Strategies. Negotiation Skills, Stress Management and Conflict Management - Meaning, Concept, steps and Techniques. Emotional Intelligence – Meaning, Concept and Importance. Creativity – Meaning, Concept, Components and Characteristics of creative people. Team Work –Meaning, Concept, Characteristic Features of Effective Teams, Types of Teams, Factors affecting and role of Team Work.

**Practical**

Communication Skills: meaning and process of communication, Simulated Exercises on verbal and nonverbal communication and Science of body language; Practicing conscious body postures and movements; Simulated Exercises on listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations. Extempore, impromptu presentation, public speaking; Simulated Exercises: on Video recorded mock group discussions and interviews, Organizing seminars and conferences. Video recorded practical to evaluate change in confidence level; Team work and Time management.

**Lecture outlines****Theory**

1. Communication - Meaning and process of communication, verbal and non verbal communication.
2. Communication skills - Structural and functional grammar.
3. Listening and note taking, writing skills, oral presentation skills.
4. Voice modulation basics and their usage for meaningful impact on people.
5. Field diary and lab record; indexing, footnote and bibliographic procedures.

6. Reading and comprehension of general and technical articles and precise writing - summarizing, abstracting; individual group presentations.
7. Extempore, impromptu and prepared presentations, public speaking; group discussion - Organizing seminars and conferences.
8. Human behaviour - Domains and components of behaviour.
9. Personality and personality development - Meaning, scope, importance, factors influencing personality - Traits and type, approaches.
10. Personality theories.
11. Importance of wants, desires, needs, drives, motives, aspirations, interests, objectives and goals in personality development.
12. Transactional analysis, - Importance, methods and strategies.
13. Negotiation skills, stress management and conflict management - Meaning, concept, steps and techniques.
14. Emotional intelligence - Meaning, concept and importance.
15. Creativity - Meaning, concept, components and characteristics of creative people.
16. Team work - Meaning, concept, characteristic features of effective teams, types of teams, factors affecting and role of team work

### **Practical**

1. Communication - Meaning and process of communication.
2. Overview of non verbal communication skills, signs of body language.
3. Non verbal communication skills - Practicing conscious body postures and movements.
4. Overview of verbal communication skills.
5. Practicing listening and note taking and writing skills.
6. Practicing oral presentation skills.
7. Practicing writing of field diary and lab record - Indexing, footnote and bibliographic procedures.
8. Practicing reading and comprehension of general and technical articles.
9. Practicing precise writing, summarizing, abstracting.
10. Exercise on individual and group presentations.
11. Practicing of extempore, impromptu, impromptu presentation, public speaking.
12. Evaluative exercises on video recorded mock group discussions and interviews.
13. Practical exposure on organizing seminars and conferences.
14. Evaluative exercise on recorded video programme to build the confidence levels of students.

15. Practical exercise on importance of team work.
16. Practical exercise on importance of time management.

### **References**

1. Dangi K.L., S.S. Sisoda, Pravesh Singh Chauhan and Yogita Ranavat. *A Text Book of Communication Skills*. Agrotech Publications.
2. Mangal S.K. 2016. *Essentials of Educational Psychology*. PHI Learning Private Ltd., New Delhi.
3. Nirajkumar. 1997. *A Genesis of Behavioural Science*. Gyan Publishing House, New Delhi.
4. Eric Berne. 1964. *Games People Play-The Psychology of Human Relationship*. Grove Press Publishers.
5. Thomas Anthony Harris. 1967. *I am Ok You are Ok*. Harper Publishers.
6. Scott Bill. 1981. *Skills of Negotiating*.
7. Goleman Daniel. 1995. *Emotional Intelligence*.
8. Ratan Reddy B and Supriya Reddy. *Soft Skills for Professional Excellence*.
9. Shivkhera. 2002. *You can win*. MacMillan Publishing Company. New Delhi
10. Shivaraman K. 2009. *Communication Skills*. APH publications.

**Course outlines****Theory**

Importance of Biochemistry - Properties of Water, pH and Buffer – Carbohydrate, Importance and classification - Structures of Monosaccharides - Reducing and oxidizing properties of Monosaccharides -Mutarotation, Structure of Disaccharides and Polysaccharides – Lipid, Importance and classification -Structures and properties of fatty acids - Storage lipids and membrane lipids – Proteins, Importance of proteins and classification, Structures - titration and zwitterions nature of amino acids - Structural organization of proteins – Enzymes, General properties and classification - Mechanism of action - Michaelis & Menten and Line Weaver Burk equation & plots - Introduction to allosteric enzymes - Nucleic acids - Importance and classification - Structure of Nucleotides, A, B & Z DNA – RNA, Types and Secondary & Tertiary structure - Metabolism of carbohydrates - Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain - Metabolism of lipids - Beta oxidation, Biosynthesis of fatty acids.

Concepts and applications of plant biotechnology - Scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications - Micro-propagation methods; organogenesis and embryogenesis - Synthetic seeds and their significance - Embryo rescue and its significance - Somatic hybridization and cybrids - Somaclonal variation and its use in crop improvement - Cryo-preservation - Introduction to recombinant DNA methods - Physical (Gene gun method), Chemical (PEG mediated) and Agrobacterium mediated gene transfer methods - Transgenics and its importance in crop improvement - PCR techniques and its applications - RFLP, RAPD, SSR - Marker Assisted Breeding in crop improvement - Biotechnology regulations.

**Practical**

Preparation of solution, pH & buffers - Qualitative tests of carbohydrates and amino acids - Quantitative estimation of glucose/ proteins - Titration methods for estimation of amino acids/lipids - Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides - Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium - Callus induction from various explants - Micro-propagation, hardening and acclimatization - Demonstration on isolation of DNA - Demonstration of gel electrophoresis techniques and DNA finger printing.

**Lecture outlines**

- 1 Introduction – Historical aspects of Biochemistry– Scope, impact and importance of Biochemistry in plant sciences -Properties of water – PH – Buffers.

- 2 Carbohydrates– Classification - Structures – Monosaccharides – Structural aspects – mutarotation - Reducing and oxidizing properties.
- 3 Oligosaccharides and polysaccharides-Functions of carbohydrates
- 4 Lipids – Fatty acids – Structures and properties – Functions of lipids
- 5 Lipids - Classification – Storage lipids and membrane lipids – Saponification, hydrogenation, Iodine number and Acid value.
- 6 Amino acids – Structures - Classification – Zwitterions – Titration
- 7 Peptides – Oligopeptides – Cyclic and acyclic peptides – Malformin, Glutathione, Gramicidin – Functions of peptides.
- 8 Proteins –Importance - Classification - Properties of proteins –Isoelectric P<sup>H</sup> – Denaturation - Protein sequencing – Edman degradation method
- 9 Proteins – Structural organization – Primary, secondary, tertiary and quaternary structures and forces involved in stabilizing proteins
- 10 Enzymes – Characteristics of enzymes – Chemical nature, speed, specificity, active site - activation energy – Mechanism of enzyme action.
- 11 Classification of enzymes - Isoenzymes – Multienzyme complex – Allosteric enzymes and coenzymes.
- 12 Measurement of enzyme activity – Factors effecting enzyme activity – Enzyme Inhibition – MM & LB plots
- 13 Nucleic acids – Functions – Structures of nitrogen bases – Nucleosides – Nucleotides in RNA and DNA.
- 14 Various types of DNA and RNA – Secondary structure of B-DNA and t-RNA.
- 15 Metabolism – Anabolism and Catabolism – Stages of respiration – Overall metabolic view of carbohydrates, proteins and lipids.
- 16 Metabolism of carbohydrates – Glycolysis – Aerobic and anaerobic.
- 17 Tricarboxylic Acid (TCA) cycle— Glyoxalate cycle – Electron transport chain
- 18 Metabolism of lipids –Biosynthesis of fatty acids and tri acyl glycerol
- 19 Catabolism of lipids  $\alpha$ ,  $\beta$  &  $\gamma$  oxidation of fatty acids in brief and  $\alpha$  oxidation in detail.
- 20 Protein Biosynthesis and post translational modifications
- 21 Secondary metabolites – Terpenoids – Alkaloids - Phenolics – Importance
- 22 Biotechnology – Major – Concepts and importance – Applications of plant biotechnology.
- 23 Introduction to plant tissue culture – History – Scientists - Terminology – Steps in general tissue culture – Types of sterilization and nutrient media – Types of cultures – Organ cultures, cell suspension culture, callus culture, pollen culture and their applications.
- 24 Micropropagation – Procedure techniques – Organogenesis and embryogenesis – Problems – Advantages – Limitations.

- 25 Anther culture – embryo culture – Ovule culture – Somatic embryogenesis - Synthetic seeds and its applications.
- 26 Protoplast isolation and fusion – Somatic hybridization – Cybrids – Somaclonal variations and applications in crop improvement – Cryo preservation
- 27 Recombinant DNA methods - Introduction to genetic engineering – Definitions – Gene cloning - Vectors.
- 28 & 29 Gene transfer methods – Indirect methods (Agrobacterium) and direct methods (physical-gene gun method; chemical-PEG mediated and other methods) with case studies / examples.
- 30 Transgenic plants – Present status - Applications in crop improvement – Limitations – biotechnology regulations.
- 31 Polymerase chain reaction (PCR) – Procedure and applications.
- 32 Markers - Morphological, biochemical and molecular markers – RFLP, RAPD and SSR – Marker assisted selection for crop improvement.

### Practical

- 1 Preparation of solutions, pH and buffers.
- 2 Qualitative tests for carbohydrates.
- 3 Qualitative tests amino acids.
- 4 Estimation of amylose in rice.
- 5 Estimation of reducing sugar/Total soluble sugars.
- 6 Estimation of proteins by Lowrys method.
- 7 Extraction of oil from oil seeds by soxhlet apparatus.
- 8 Effect of P<sup>H</sup>, temperature and substrate concentration on enzyme action.
- 9 Paper chromatography / TLC demonstration for separation of amino acids.
- 10 Sterilization techniques.
- 11 Composition of various tissues culture media and preparation of stock solutions for MS nutrient medium.
- 12 Callus induction from various explants.
- 13 Micropropagation – Hardening and acclimatization.
- 14 Demonstration of isolation of DNA and of gel electrophoresis technique.
- 15 Demonstration of PCR Technique.
- 16 Demonstration of DNA finger printing –RAPD and Restriction digestion.

### References:

1. David L. Nelson, Michael M.Cox; W.H. Freeman. *Lehninger Principles of Biochemistry*, 6<sup>th</sup> Edition
2. *Biochemistry*, Dr.U.Satyanarayana, Dr.U. Chakrapani, Books and Allied(P) Ltd, Kolkata
3. *Biochemistry*, S.N.Gupta, Rastogi Publications, First Edition, 2011
4. *Introduction to Plant Biotechnology* by HS Chawla (3<sup>rd</sup> Edition), Oxford & IBH Publishing Co. Pvt Ltd., New Delhi.

**Course outlines****Theory**

Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.); Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions); Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.); Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/ modified diets, Menu planning, New trends in food science and nutrition.

**Lecture outlines**

- 1 Concepts of food science - Definitions of food, specific nutrients in foods and their functions - Physical characteristics of foods - Importance
- 2 Food physical characteristics - Density - Phase change, pH, osmosis, surface tension, colloidal systems.
- 3 Food composition - Food chemistry - Water, solutions, water balances in body, clinical signs of water depletion, excessive water intake, recommended requirements
- 4 Carbohydrates - Structure, properties of sugars, starches, cellulose and hemicelluloses, pectin, gums.
- 5 Proteins - Structure, amino-acids, properties.
- 6 Fats and oils - Structure, functional aspects.
- 7 Vitamins - Retinol, vitamin D, vitamin E, vitamin K, ascorbic acid, B-complex group
- 8 Minerals, pigments, colours, flavours
- 9 Natural emulsifiers.
- 10 Organic acids.
- 11 Oxidants and antioxidants.
- 12 Enzymes.
- 13 Food microbiology - Morphology and fine structure of bacteria - Cultivation of bacteria, nutritional requirements -Nutritional classification of bacteria.
- 14 Introduction to yeast, algae and protozoa and virus, general characteristics
- 15 Microbial spoilage of foods - Factors affecting kinds, numbers, growth and survival of microorganisms in foods.
- 16 Production of fermented foods - Production, purification and estimation of beer/ ethanol.
- 17 Preservation by heat treatment - Principle and equipment for blanching.
- 18 Preservation by heat treatment - Canning, pasteurization, sterilization.

- 19 Preservation by use of low temperature - Principle, methods, equipment
- 20 Preservation by chemicals - Antioxidants, mould inhibitors, antibodies, acidulants, etc.
- 21 Preservation by irradiation - Principle, methods, equipment.
- 22 Preservation by fermentation - Principles, methods, equipment
- 23 Preservation by drying, dehydration and concentration - Principle, methods, equipment.
- 24 Food and nutrition - History of diet around the world - European diet.
- 25 Malnutrition (over and under nutrition), body cell, digestion and absorption, energy and calories, obesity and weight control.
- 26 Nutritional disorders that can compromise health.
- 27 Energy metabolism - Carbohydrates, individual sugars, sugars and diabetes mellitus, glycemic response, dietary carbohydrates
- 28 Energy metabolism - Fat, synthesis, control, biosynthesis, cellular degradation, peroxidation.
- 29 Energy metabolism - Proteins, synthesis, catabolism, ammonia and urea.
- 30 Balanced/modified diets, diet selection.
- 31 Menu planning.
- 32 New trends in food science and nutrition.

## References

1. Sumati R. Mudambi, Shalini M. Rao and M.V. Rajagopal. 2006. *Food Science*, 2<sup>nd</sup> Ed. New Age International (P) Limited, New Delhi.
2. Martin Eastwood. 2003. *Principles of Human Nutrition*. Blackwell Science Ltd., Oxford.
3. Norman N. Potter. 1998. *Food Science*, 5<sup>th</sup> Ed. Springer Science+ Business Media, New York.
4. Michael J. Pelczar Jr., E.C.S. Chan and Noel R. Krieg. 1998. *Microbiology*, 5<sup>th</sup> Ed. Tata McGraw-Hill Education, New Delhi.
5. William C. Frazier and Dennis C. Westhoff. 1987. *Food Microbiology*, 4<sup>th</sup> Ed. Tata McGraw-Hill Education, New Delhi.
6. L.E. Casida Jr. 1968. *Industrial Microbiology*. New Age International Publishers, New Delhi.
7. P. Fellows. 2000. *Food Processing Technology: Principles and Practice*, 2<sup>nd</sup> Ed. CRC Press, Boca Raton, FL, USA.
8. Marcus Karel and Darvl B. Lund. 2003. *Physical Principles of Food Preservation*, 2<sup>nd</sup> Ed. Marcel Dekker, Inc., NY, USA.
9. Gerald Wiseman. 2002. *Nutrition and Health*. Taylor & Francis, London.
10. *An Introduction to Nutrition*, v. 1.0

**Course outlines****Theory**

Role of live-stock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of live-stock and poultry. Introduction of live-stock 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 live-stock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of live-stock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of live-stock and poultry. Planning and layout of housing for different types of live-stock. 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 Demographic distribution of live-stock population.
- 2 Population dynamics of live-stock and role in Indian economy.
- 3 Reproduction in live-stock and poultry.
- 4 Housing systems live-stock and poultry.
- 5 Design and construction of live-stock and poultry buildings.
- 6 Selection of site and General principles affecting the design.
- 7 Arrangements of building.
- 8 Building materials
- 9 Indian breeds of cattle, buffalo, sheep, goat, swine and poultry
- 10 exotic breeds of cattle, buffalo, sheep, goat, swine and poultry
- 11 Management of calves, growing heifers and milch animals
- 12 Management of sheep, goat and swine
- 13 Incubation, hatching and brooding

- 14 Improvement of live-stock and poultry.
- 15 Digestion and metabolism live-stock and poultry.
- 16 Classification of feedstuffs for live-stock and poultry.
- 17 Proximate principles of feed.
- 18 Nutrients and their functions.
- 19 Feed ingredients for ration- Balanced ration.
- 20 General principles of computation of ration.
- 21 Formulation of rations and feeding dairy cattle and buffaloes.
- 22 Formulation of rations sheep, goat and swine and poultry.
- 23 Feed supplements Feed additives in the rations of live-stock and poultry.
- 24 Feeding of live-stock and poultry.
- 25 Diseases of cattle and buffaloes.
- 26 Diseases of sheep, goat and swine.
- 27 Diseases of Poultry.
- 28 Sanitation – Sanitation of live-stock and poultry houses.
- 29 Prevention of infectious diseases in live-stock and poultry.
- 30 Vaccination schedule for cattle and buffaloes sheep, goat.
- 31 Vaccination schedule for swine and poultry.
- 32 Control of infectious diseases in live-stock and poultry.

### **Practical**

- 1 Familiarizing with body points/parts of different domesticated animals and poultry.
- 2 Approaching, handling methods of restraining.
- 3 Casting of live-stock.
- 4 Identification methods of farm animals and poultry (branding, tattooing, notching & tagging).
- 5 A visit to the live-stock and poultry farms.
- 6 Identification of various breeds and familiarizing with various farm routines and farm records.
- 7 Judging of cattle, buffalo and poultry.
- 8 Culling of live-stock and poultry.
- 9 Layout plans for different live-stock and Poultry houses.
- 10 Computation of rations for live-stock and Poultry.
- 11 Formulation of concentrate mixtures and Poultry.
- 12 Clean milk production and milking methods.
- 13 Hatching equipments Hatchery operations and incubation.
- 14 Management of chicks, growers and layers.
- 15 Debeaking, dusting and vaccination.
- 16 Economics of cattle, buffalo, sheep, goat, swine and poultry production.

**Course outlines**

**Theory**

Introduction- Scope of microbiology & brief history of microbiology. Microbial world- Prokaryotic and eukaryotic microbes and their differences, Bacteria- Detailed cell structure of bacteria, Microbial Nutrition- Autotrophy-chemoautotrophy, photo autotrophy, heterotrophy. Growth-Phases in bacterial growth, synchronous and diauxic Growth. Bacterial genetics- Genetic recombination- transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon cycle. Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. *Azolla*, blue green algae, Actinorrhizal symbiosis- *Frankia*. Phosphorus solubilizing microorganisms and *mycorrhiza*. Rhizosphere and phyllosphere. PGPR microorganisms. Microbes in human welfare, Types of Fermentation and Fermentation technology, Biofertilizers and silage production technology, Biopesticides-Mode of action, types of biopesticides, Biofuel production and biodegradation-Gobar gas and composting technology.

**Practical**

Introduction to microbiology laboratory and its equipments, Microscope- Parts, principles of microscopy, resolving power and numerical aperture, Micrometry- Measurement of size of microorganisms, Methods of sterilization, Bacterial Staining procedures- Simple staining, Gram's staining and Endospore staining, Nutritional media and their preparations, Enumeration of microbial population in soil- bacteria, fungi and actinomycetes. Methods of isolation, purification and maintenance of microbial cultures. Isolation of *Rhizobium* from legume root nodule. Isolation of *Azotobacter*. Isolation of Phosphate solubilising bacteria/Phosphate solubilizing fungi. PSB/PSF. Isolation of *Azospirillum* from roots. Staining and microscopic examination of biofertilizer organisms. Isolation of *VAM* from soil by wet sieving and decantation Technique. Determination of *VAM* root colonization by staining the infected roots.

**Lecture outlines**

**Theory**

1. Introduction- Definition- The hidden world of microbiology- How microbes evolved on earth- General classification of microbes-Microorganisms and principles of microbiology- Scope of microbiology. Brief History of microbiology - Spontaneous generation theory- Contributions of Antony Van Leeuwenhoek- Francesco Redi- Lazzaro Spallanzani- Franz Schulze- Schroder and Von Dusch- Louis Pasteur- John Tyndall.
2. Role of microbes in fermentation-Contributions of Cagnaird Latour-Theodor Schwann, F.Kutzing- Louis Pasteur - Germ theory of disease - Contribution of

Hippocrates-Louis Pasteur- Robert Koch - Pure Culture Methods- Joseph Lister- Robert Koch- Beijerinck-Winogradsky- Francois Appert- Schroder and Von Dush- John Tyndall.

3. Protection against infection-Contributions of Edward Jenner- F. Loeffler- Behring- Kitasasto- Louis Pasteur - Applied aspects of Microbiology- Agricultural microbiology-Industrial microbiology-Food Microbiology - Medical microbiology – Water Microbiology - Geochemical Microbiology- Pollution microbiology – Air microbiology – Exo-Microbiology - Microbial biotechnology.
4. Morphological types of Bacteria , Bacteria cell Structure- External and internal cell structures- Differences between Prokaryotes and Eukaryotes.
5. Microbial Nutrition- Autotrophy - Chemoautotrophy- Photoautotrophy
6. Heterotrophy – Metabolic pathways-Glycolysis-HMP-ED-TCA cycle.
7. Growth of Microorganisms - Cell Division - Growth cycle of bacteria [ Lag phase, Log phase, Stationary and Death phase]- Generation time- Growth rate- Growth yield- Synchronous - Diauxic growth.
8. Bacterial genetics- Genetic recombination- Transformation- Conjugation- Transduction- Plasmids- Transposon.
9. Role of microbes in fertility of soils and plant growth - Rhizosphere- Rhizoplane- Phyllosphere- Phylloplane - Microflora- Carbon cycle- Carbon dioxide fixation.
10. Nitrogen cycle - Mineralisation- Immobilisation- Nitrification- Denitrification- Nitrogen Fixation - Phosphorus cycle, phosphorus solubilisation – Oxidation – Reduction - Sulphur cycle-Oxidation and reduction.
11. Biological nitrogen fixation - Symbiotic- Associative- Asymbiotic- Nitrogen fixation In *Azolla* - *Blue green algae* - Actinorhizal symbiosis - *Frankia*, Phosphate solubilizing microorganisms - *Bacillus* - *Pseudomonas*- *Mycorrhiza* for Phosphorous uptake.
12. PGPR Organisms - *Bacillus* – *Pseudomonas* – *Azotobacter* – *Azospirillum* - *Rhizobium* -Microbes in human welfare.
13. Types of fermentations - Batch - Batch fed- Continuous - Solid State Fermentations, Common microbial fermentations-Alcohol- Lactic acid- Butyric acid- Formic acid - Butanediol- Propionic Acid- Mixed Acid - Fermentation technology- Alcoholic beverages production.
14. Biofertilizers (Bacterial-Cyanobacterial-Fungal) production technology- Silage Production Technology.
15. Biopesticides- Viruses (*Nucleo polyhedrosis virus* - *Granular viruses*) – Bacteria (*Bacillus thuringiensis*, *Bacillus papilliae* ) - fungi (*Beauveria* - *Verticillium*) - Protozoa (*Malameba locustae*-*Mattesia Spp*)-Mode of action.

16. Biofuel Production- Biodegradation - Biogas, Biomanures and Composting Technologies.

### Practical

1. Introduction to microbiology laboratory and its equipments.
2. Microscope- Parts, principles of microscopy, resolving power and numerical aperture.
3. Micrometry-Measurement of size of microorganisms.
4. Methods of sterilization.
5. Bacterial staining procedures-Simple staining - Gram's staining and Endospore staining.
6. Nutritional media and their preparations.
- 7 & 8. Enumeration of microbial population in soil- Bacteria, fungi and actinomycetes.
9. Methods of isolation, purification and maintenance of microbial cultures.
10. Isolation of *Rhizobium* from legume root nodule.
11. Isolation of *Azotobacter*.
12. Isolation of phosphate solubilising bacteria/Phosphate solubilizing fungi PSB/PSF.
13. Isolation of *Azospirillum* from roots.
14. Staining and microscopic examination of biofertilizer organisms.
15. Isolation of *VAM* from soil by wet sieving and decantation technique.
16. Determination of *VAM* root colonization by staining the infected roots.

### References

1. *Microbiology*. Pelczar, J.r., M.J.E.C.S.Chan and Krieg, N.R. (5<sup>th</sup> Ed.) 2015. McGraw Hill Publishers, New York.
2. *Microbiology*. Prescott, L.M., Harley, J.P. and Klein, D.A. (9<sup>th</sup> Ed.) 2014. McGraw Hill Publishers, New York.
3. *Brock Biology of Microorganisms*. Madigan, M., Martinko, J.M and Parker, J. (14<sup>Ed.</sup>) 2015. Prentice hall of India Pvt Ltd., New Delhi.
4. *Soil Microbiology*: Subba Rao, N.S. (4<sup>th</sup> Ed.) 2014. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
5. *Microbiology A Laboratory Manual*: James, C and Natile, S. (10<sup>th</sup> Ed.) 2014. Pearson India Education Services Pvt. Ltd., South Asia.
6. *Experiments in Microbiology, Plant Pathology and Biotechnology*. Aneja, K.R.2011. New Age International (P) Ltd., Publishers, New Delh

**Course outlines**

**Theory & Practical**

Matrices and Determinants : Definition of matrices- Addition- Subtraction- Multiplication- Transpose and Inverse up to 3<sup>rd</sup> order, Properties of determinants up to 3<sup>rd</sup> order and their evaluation. Cramer's rule and simple problems based on it.

Differential Calculus: Definition of function- limit and continuity (Simple problems). Differentiation of  $x^n$ ,  $e^x$ -  $\sin x$  and  $\cos x$  by first principle - Derivatives of sum-difference product and quotient of two functions. Differentiation of functions of functions (Simple problems based on it) - Logarithmic differentiation (Simple problems based on it). Differentiation by substitution ( Simple Problems) - Differentiation of Inverse Trigonometric functions - Equations of Tangent - Normal of given curve at given point. (Simple Problems used on it) - Maxima and Minima (Simple problems).

Integral Calculus : Integration of functions - Integration of Product of two functions- integration by substitution method - Definite Integral (Simple problems based on it) - Area under simple well-known curves (simple problems based on it).

Straight lines : Distance formula - section formula change of axes (only origin changed), Equation of lines (Slope-intercept, Slope-point, Two point, Intercept, Normal & General forms) - Point of inter section of two straight lines - Angles between two straight lines - Angle of bisectors between two lines - Area of triangles and quadrilateral.

Circle : Standard and General Equation of circle - Equation of circle passing through three given points - Equation of circle whose diameters is line joining two points - Tangent and Normal to a given circle at given point (Simple problems) - Condition of tangency of a line to circle.

Parabola : General and standard equations of parabola - Vertex, focus, equation of directrix, length of lotus rectum - Equation of tangent and normal to a given point (simple problems) -Conditions of tangency of line  $y = mx + c$  to  $y^2 = 4ax$ .

Ellipse : Standard form of the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  - Focus - directrix, vertex of the ellipse in both cases ( $a > b$ ,  $b > a$ ) - Equation of tangent - normal at given points to a given ellipse (Simple problems).

**Lecture outline**

**Theory**

- 1 Definition of matrices, order of a matrix - Type of matrices- Addition- Subtraction - Multiplication - Transpose of matrix - Minor.
- 2 Define Co-factor of matrix - A Inverse matrix up to 3<sup>rd</sup> order - Definition of determinants and properties of determinants up to 3<sup>rd</sup> order and their evaluation- Cramer's rule and simple problems based on it.
- 3 Definition of function - Limit and continuity with Simple problems.

- 4 Differentiation of  $x^n - e^x - \sin x$  and  $\cos x$  by first principle - Derivatives of sum-Difference product and quotient of two functions - Differentiation of functions of functions (Simple problems based on it).
- 5 Logarithmic differentiation (simple problems based on it) - Differentiation by substitution simple problems) - Differentiation of inverse trigonometric functions - Equations of tangent - Normal of given curve at given point.
- 6 Define Maxima and Minima with simple problems.
- 7 Integration of functions - Integration of product of two functions - Integration by substitution method.
- 8 Definite Integral (simple problems based on it) - Area under simple well-known curves (simple problems based on it).
- 9 Introduction to Co-ordinate geometry and give distance formula - Section formula with examples.
- 10 Define straight line and write different types of straight line forms with examples. Solve the angles between two straight lines - Area of triangle and quadrilateral.
- 11 Definition of standard and general equation of circle - Equation of circle passing through three given points.
- 12 Tangent and normal to a given circle at given point (simple problems) - Condition of tangency of a line to circle.
- 13 Definition of general and standards equations of parabola - Vertex - Focus - Equation of directrix - Length of lotus rectum.
- 14 Equation of tangent and normal to a given point (simple problems) - Conditions of tangency of line  $y = mx + c$  to  $y^2 = 4ax$ .
- 15 Define standard form of the ellipse. Focus – Directrix - Vertex of the ellipse in both cases ( $a > b$ ,  $b > a$ ).
- 16 Equation of tangent - Normal at given points to a given ellipse with problems.

### **Practical**

- 1 Problems on Addition- Subtraction-Multiplication - Transpose of matrix 3<sup>rd</sup> order.
- 2 Problems on minor - Co-factor of matrix - Inverse of matrix up to 3<sup>rd</sup> order.
- 3 Cramer's rule and simple problems based on it and problems on determinants.
- 4 Function limit and continuity with simple problems.
- 5 Problems on differentiation of  $x^n - e^x - \sin x$  and  $\cos x$  by first principle.
- 6 Derivatives of sum - difference product and quotient of two functions - Differentiation of functions of functions - Simple problems based on it.
- 7 Logarithmic - Inverse - Trigonometric functions- Functions of functions - Equations of tangent - Normal of given curve at given point - Simple problems.
- 8 Problems on integration of functions - Integration of product of two functions - Integration by substitution method.

- 9 Integral (simple problems based on it) - Area under simple well-known curves (simple problems based on it).
- 10 Problems on different types of straight line forms.
- 11 Problems on angles between two straight lines - Area of triangle and quadrilateral.
- 12 Problems on equation of circle passing through three given points.
- 13 Problems on parabola – Vertex – Focus - equation of directrix - Length of latus rectum.
- 14 Problems on equation of tangent and normal to a given point - Conditions of tangency of line  $y = mx + c$  to  $y^2 = 4ax$
- 15 Problems on standard form of the ellipse - Focus – Directrix - Vertex of the ellipse in both cases ( $a > b$ ,  $b > a$ ).
- 16 Equation of tangent - Normal at given points to a given ellipse - Simple problems.

### References

1. MVSL DN Raju and Dr. K .V. Ramana – *Engineering Mathematics-1*
2. MVSL DN Raju and Dr. K .V. Ramana – *Engineering Mathematics-2*
3. *Text Book for A.P Intermediate Mathematics – Paper (IA & IIB)*.
4. MVSL DN Raju and K.V. Ramana - *Agricultural Mathematics*.

**SMCA 201**

**STATISTICAL METHODS**

**2(1+1)**

### Course outlines

#### Theory

Introduction to Statistics and its Applications in Agriculture - Graphical Representation of Data. Measures of Central Tendency- Dispersion - Skewness and Kurtosis. Definition of Probability - Addition and Multiplication Theorem - Simple Problems Based on Probability Theory. Binomial - Poisson - Normal Distributions and their Properties. Definition of Correlation - Scatter Diagram - Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance - One sample -Two Sample Test for Means. Chi-Square Test of Goodness of fit - Chi-Square Test of Independence of Attributes in  $2 \times 2$  contingency table. Introduction to Analysis of Variance - Analysis of One Way and Two Way Classification. Introduction to Sampling Methods - Sampling versus Complete Enumeration - Simple Random Sampling with and without replacement - Use of Random Number Tables for selection of Simple Random Sample.

#### Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles - Deciles - Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles - Deciles - Percentiles. Measures of Dispersion (Ungrouped Data)- Measures of Dispersion (Grouped Data). Moments -

Measures of Skewness & Kurtosis (Ungrouped Data). Moments - Measures of Skewness and Kurtosis (Grouped Data). Correlation and Regression Analysis. Application of One Sample t-test - Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit - Chi-Square test of Independence of Attributes for 2 x 2 contingency table. Analysis of Variance One Way Classification - Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling.

## Lecture outlines

### Theory

1. Introduction and various definitions of Statistics - Singular and plural reference of Statistics - A comprehensive definition of Statistics - Importance of Statistics in agriculture - limitations of statistics.
2. Frequency Distribution- Exclusive and inclusive methods - Discrete and continuous variables - Graphical representation of data
3. Central tendency-Definition - Measures of Central tendency - List of all the different measures and study of Arithmetic Mean – Median - Mode in detail (including merits and demerits) for ungrouped and grouped data.
4. Measures of Dispersion – Meaning of measures of Dispersion - Standard Deviation for ungrouped and grouped data- Coefficient of Variation (C.V) - Standard Error (S.E.) and difference between S.D. and S.E.
5. Definition of Probability – Addition - Multiplication theorems - Binomial and Poisson distributions
6. Normal Curve and its properties - Identification of normality through data i.e., criterion. etc., expression for frequency function of Normal distribution
7. Testing of Hypothesis – Concept - Null hypothesis - Type I and Type II Errors - Level of Significance - Critical region - General setup of testing - Large Sample Test with known and unknown
8. Small Sample test (t-test for one and two samples and Paired t- test) and F-test
9. Chi-Square test for 2x 2 and m x n contingency Table - Yate's correction for Continuity
10. Correlation – Scatter diagram - Positive and negative correlation and its testing
11. Regression – Fitting of linear regression equation of Y on X and X on Y and the inter relation-ship with "r" and testing of regression coefficients
12. Analysis of Variance (ANOVA) - Definition and assumptions - ANOVA with One-way classification (CRD) layout and analysis with equal and unequal repetitions, Advantages and disadvantages
13. ANOVA with Two way Classification (RBD) - Layout and analysis, Advantages and disadvantages
14. ANOVA with three way classification (LSD) – Layout and Analysis - Advantages and disadvantages.

15. Introduction to Sampling - Sampling Vs Census - Purposive and Random Sampling
16. Simple Random Sampling - Method of selection - Estimates of population mean and total and the estimates of their variances and confidence limits.

### **Practical**

1. Preparing frequency distribution for ungrouped data by using inclusive and exclusive methods and calculation of quartile - Deciles and Percentiles.
2. Preparing various graphs and charts.
3. Computation of A.M, Median and Mode for grouped and un-grouped data by direct and deviation methods.
4. Problems on calculating skewness and kurtosis - S.D and CV% for grouped data
5. Problems on probability.
6. Problems on binomial and poisson distributions.
7. Normal curve and its properties, identification of normality through data i.e., criterion. etc., - Expression for frequency function of normal distribution.
8. Problems on Z- test for one Sample - Two sample with known and unknown conditions of.
9. Student's t-test for single sample - Two sample and paired t- test - F-test (Test for homogeneity of variances).
10. Problems on Chi-square test and Yates correction
11. Problems to calculate the correlation coefficient and its testing.
12. Fitting of Linear Regression and its testing.
13. Analysis of CRD with equal and unequal repetitions.
14. Analysis of RBD.
15. Analysis of LSD.
16. Problems on simple random sampling.

### **References**

1. Nageswara Rao, G 2007. *Statistics for Agricultural Sciences*. B S Publications, Hyderabad
2. Rangaswamy, R 1995. *A Text Book of Agricultural Statistics*. New Age International (P) Limited, Hyderabad.
3. Chandel SRS, *Hand Book of Agricultural Statistics*. Achal Prakashan Mandir publications, New Delhi.
4. Agrawal, B .L. *Programmed Statistics*. 2<sup>nd</sup> Edition, New Age International Publishers, Hyderabad.

**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 a document, Data presentation, tabulation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, creating database, uses of DBMS in Agriculture, Internet and World Wide Web (WWW), Concepts, components and creation of web, HTML, XML coding.

e-Agriculture, concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in Agriculture. ICT for Data Collection, formation of development programmes, monitoring and evaluation of Programmes. 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 application 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 advises, market price, postharvest management etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information. Decision support systems, taxonomy, components, framework, classification and applications in Agriculture, DSS, Agriculture Information/Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools.

**Practical**

Study of Computer Components, accessories, Introduction of different operating systems such as windows, Unix, Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Powerpoint for creating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, art tool, graphics, template & designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Preparation of Inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology, demonstration of generating information important for Agriculture. Hands on practice on preparation of Decision Support System.

## Lecture outline

### Theory

1. Introduction to computers- Advantages- Disadvantages- Applications - Anatomy of Computers- Input / output devices -Memory Concepts - Units of Memory - RAM – ROM – PROM – EPROM - EAPROM - Cache Memory.
2. Operating system - Definition and types - WINDOWS OS – Features – Desktop – Icons etc.
3. Applications of MS-Office - MS- Word - Creating - Editing and formatting a document.
4. MS Word - Features of good word processor - Mail merge – Drop cap- Auto text-Track changes – Equation editor etc.
5. MS- Excel - Data presentation, Tabulation – Merging of cells and graph creation - Mathematical expressions.
6. MS- Excel - Data analysis tool pack – Pivot table and graph etc.,
7. MS Access – Database - concepts and types - creating database - Uses of DBMS in agriculture.
8. MS Access - Objects of data base – Types of fields etc.,
9. Internet and World Wide Web (WWW) – Concepts - Components and creation of web.
10. HTML - XML coding.
11. e-Agriculture - Concepts - Design and development - Application of innovative ways to use information and communication technologies (IT) in Agriculture.
12. ICT for Data Collection - Formation of development programmes - Monitoring and evaluation of Programmes - 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.
13. IT application 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 advises - Market price - Postharvest management etc.,
14. Geospatial technology – Concepts – Techniques - Components and uses for generating valuable agri-information.
15. Decision support systems – Taxonomy – Components – Framework - Classification and applications in Agriculture - DSS - Agriculture Information/Expert System - Soil Information Systems etc for supporting Farm decisions.
16. Preparation of contingent crop-Planning and crop calendars using IT tools.

## Practical

1. Booting of computer and its shut down - Practicing Windows operating system - Use of mouse -Title bar – Minimum, maximum and close buttons - Scroll bars - Menus and tool bars.
2. Windows explorer- Creating folder - Copy and paste functions - Control panel- Notepad -Wordpad etc.
3. MS word - Creating a document, saving and editing
4. Use of options from tool bars – Format - Insert and tools (Spelling and Grammar) - Alignment of paragraphs and text.
5. Creating a table - Merging of cells - columns and row width - Formats etc.
6. MS- Excel - Creating a spreadsheet - Alignment of rows - columns and cells using format tool bar.
7. Entering formula expression through formula tool bar and use of in-built functions Sum – Average – Stdev –Maximum and minimum.
8. Data analysis using inbuilt tool packs test of significance.
9. Data analysis using inbuilt tool packs correlations and regressions.
10. Creating graphs and saving with and without data.
11. MS- Power Point - Creating slides, layouts, action buttons, multimedia features.
12. MS- Access - Creating a data base, structuring with different types of fields.
13. Use of query facility for accessing the information.
14. Transforming the data of word - Excel and Access to other formats.
- 15&16. Internet concepts - Creating Email - Search Engines - Website designing.

## References

1. John Walkenbach, Herb Tyson, Michael R. Groh, Faithe Wempen, Microsoft Office 2010 Bible
2. Bangia, Learning Ms Office 2010
3. Prof. Satish Jain and M. Geetha, MS-Office 2010 Training Guide
4. Johnson, Microsoft Office 2010.....on Demand
5. Kate Shoup, Microsoft Office 2010
6. Melanie Gass, It's All about You! Office 2010
7. Nancy Conner and Matthew MacDonald, Office 2010: The Missing Manual

**Lecture outlines****Theory**

1. War minus shooting – A lesson from the text book “The Sporting Spirit” by George Orwell - Comprehension pertaining to the textual grammar - Fill in the blanks, matching and vocabulary.
2. War Minus Shooting – A lesson from the text book, “The Sporting Spirit” by George Orwell - Comprehension pertaining to the textual grammar - Fill in the blanks, matching and vocabulary.
3. Synonyms- List of synonyms - Choose the synonyms - Exercises - Practice and implementation.
4. Antonyms – Fill in the blanks - Choose the correct antonyms - Exercises Practice and implementation.
5. Verbal ability – A list of words often confused and misused - Practice and implementation.
6. A Dilemma – A lesson from the text book, “Layman looks at Science” by Raymond - B. Fosdick - Comprehension pertaining to the textual Grammar - Fill in the blanks, matching, vocabulary and reading comprehension.
7. A Dilemma – A Layman looks at Science - Reading comprehension and answering the questions.
8. Homonyms - Homonyms are distinct words with quite different meanings using the words in two ways - More words at a glance and exercises related to GRE and TOEFL.
9. Homophones – A list of homophones - Fill in the blanks, underline the correct word and exercises related to GRE and TOEFL.
10. You and Your English – A lesson from the text book, “A Spoken English and Broken English” by G. B. Shaw – Answering the questions related to the text - Fill in the blanks, matching and vocabulary and reading comprehension.
11. You and Your English – Reading comprehension and answering the questions.
12. Functional Grammar – Tenses - Active voice and passive voice - Degrees of comparison and types of sentences - Direct and indirect speech and agreement of verb with subject functional grammar – Articles – Prepositions - Parts of speech and agreement verb with subject - Glossary.
13. Business correspondence - Principles of letter – Writing - Courtesy and consideration - Directness and conciseness, avoid – Verbosity and participia endings - Clarity and precision - Negative and roundabout - Structure and layout

of letters - Planning a letter quotations, orders, tenders, sales letters, claim and adjustment letters, job application letters - Social correspondence – Personal correspondence and *curriculum vitae*.

14. The style - Importance of professional writing - Choice of words and phrases, clichés - Jargons - Foreign words and phrases.
15. Precise writing- Summarizing – The essential features of a good precise – Important points while making a precise - Some don'ts - Make a precise of the following paragraph and suggest suitable title - Figurative language – Figurative language associated with literature and with poetry - The figures of speech usually used in writing and conversation.
16. Interviews – The screening interview- The informational interview- The directive style - The meandering style - The stress interview - The behavioural interview - The audition - The tag team interview - The meal time interview - The follow-up interview - Fermi interview - Preparing for the interview - Body language and interview - Types of interview questions - Idiomatic language.

### **Practical**

1. Effective listening – Developing listening skills – Honing listening skills.
2. Listening to short talks and lectures from the cassettes of EFL University.
3. Spoken english – Vowels – Consonants - Monophthongs, diphthongs, triphthongs.
4. Stress – Intonation - Phonetic transcription.
5. Seminars – Conferences - Preparation and demonstration.
6. Oral presentation by students - Articulation and delivery – Evaluation sheet for oral presentation.
7. Communication skills – Verbal communication - Written communication.
8. Telephonic conversation.
9. Reading skills - Skimming, scanning - Extensive reading - Intensive reading and examples.
10. Meeting - Purpose, procedure, participation, physical arrangements.
11. Presentation of reports by using power point and L.C.D.
12. Interviews – Mock interviews .
13. Debate and Group discussion.
14. Using a dictionary effectively.
15. Vocabulary.
16. Pronunciation practice.

## References

1. Balasubramanian, T. 1989. *A Text Book of Phonetics for Indian Student*, Orient Longman, New Delhi.
2. Balasubramanyam, M. 1985. *Business Communication*. Vani Education Books, New Delhi.
3. Jean Naterop, B. and Rod Revell. 1977. *Telephoning in English*. Cambridge University Press, Cambridge.
4. Krishna Mohan and Meera Banerjee. 1990. *Developing Communication Skills*. Mc Millan India Ltd. New Delhi.
5. Krishanswamy, N and Sriraman, T. 1985. *Current English for Colleges*. Mc Millan India Ltd., Madras.
6. Narayanaswamy V R. 1979. *Strengthen Your Writing*. Orient Longman, New Delhi.
7. Sharma R C and Krishna Mohan. 1978. *Business Correspondence*. Tata Mc Graw Hill Publishing Company, New Delhi.

**Course outlines**

Introduction and basic components of NSS, NSS programmes and activities, Understanding youth, Community mobilization, Social harmony and national integration, Volunteerism and shramdan, Citizenship, constitution and human rights, Family and society, Importance and role of youth leadership, Life competencies, Youth development programmes, Health, hygiene and sanitation, Youth health, lifestyle, HIV AIDS and first aid, Youth and yoga , Vocational skill development, Issues related environment, Disaster management, Entrepreneurship development, Formulation of production oriented project, Documentation and data reporting, Resource mobilization, Additional life skills, Activities directed by the Central and State Government

**Lecture outlines**

- 1 Introduction and basic components of NSS – Orientation - History, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health
- 2 NSS programmes and activities - Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary
- 3 Understanding youth - Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change
- 4 Community mobilization -Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership
- 5 Social harmony and national integration - Indian history and culture, role of youth in nation building, conflict resolution and peace-building
- 6 Volunteerism and shramdan - Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism
- 7 Citizenship, constitution and human rights - Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information
- 8 Family and society - Concept of family, community (PRIs and other community based organisations) and society
- 9 Importance and role of youth leadership - Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership
- 10 Life competencies - Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

- 11 Youth development programmes - Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organisations
- 12 & Health, hygiene and sanitation - Definition needs and scope of health education;
- 13 role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health
- 14 Youth health, lifestyle, HIV AIDS and first aid - Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid
- 15 & Youth and yoga - History, philosophy, concept, myths and misconceptions about
- 16 yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method
- 17 & Vocational skill development - To enhance the employment potential and to set
- 18 up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list
- 19 Issues related environment - Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management
- 20 & Disaster management - Introduction and classification of disaster, rehabilitation
- 21 and management after disaster; role of NSS volunteers in disaster management.
- 22 Entrepreneurship development - Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution
- 23 Formulation of production oriented project - Planning, implementation, management and impact assessment of project
- 24 Documentation and data reporting - Collection and analysis of data, documentation and dissemination of project reports
- 25 & Youth and crime - Sociological and psychological factors influencing youth crime,
- 26 cyber crime, peer mentoring in preventing crime and awareness for juvenile justice
- 27 & Civil/self defence - Civil defence services, aims and objectives of civil defence;
- 28 needs and training of self defence
- 29 & Resource mobilisation - Writing a project proposal of self fund units (SFUs) and its
- 30 establishment
- 31 & Additional life skills - Positive thinking, self confidence and esteem, setting life
- 32 goals and working to achieve them, management of stress including time management.

**Course outlines****Theory**

Principle of pH meter, EC meter, spectrophotometer, flame photometer and AAS.

Soil analysis: Objectives, sampling of soil, procedure and precautions. Determination of texture, bulk density. Interpretation of analytical data viz., pH, EC, organic carbon, N, P, K, S and micronutrients (Fe, Mn, Zn, Cu, B) and nutrient index. Plant analysis: Sampling stages and plant part to be sampled. Analysis of nutrients, Quantitative rating of plant analysis data and interpretation of results, critical nutrient concentration, critical nutrient ranges. Water analysis: Quality criteria, classification and suitability of irrigation water and water quality index. Use of soil testing kit for major and micronutrient analysis.

Seed: Introduction, definition and importance, seed germination, viability, vigor and storage.

**Practical**

Standardization of solutions and reagents, collection and preparation of soil samples, estimation of pH, EC, organic carbon, NPKS, micronutrients, CEC and exchangeable sodium in soil. Determination of EC and pH of saturation extract/paste. Estimation of cations and anions. Plant sampling and sample preparation for analysis, digestion of plant material and estimation of N, P, K in plant. Rapid plant tissue test for N, P, and K. Determination of EC, pH, cations ( $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ) and anions ( $\text{B}$ ,  $\text{CO}_3^{--}$ ,  $\text{HCO}_3^-$ ,  $\text{Cl}^-$ ) in irrigation water . Computation of SAR and RSC.

Seed quality testing: Germination, viability, moisture and vigor.

**Lecture outlines****Theory**

1. SSAC pH definition, derivations, pH chart- Soil pH, its importance in crop nutrition, rating chart-Working problems on pH &  $\text{H}^+$  &  $\text{OH}^-$  ion concentrations, measurement of pH in soils & irrigation water.
2. SSAC EC, definition, principle of Wheatstone bridge-Effect of EC on seed germination, water & nutrient uptake, measurement of EC of soils and irrigation waters.
3. SSAC Working principle of spectrophotometer - Colorimetry, Beer- Lambert law, working principle of flame photometer- Emission spectrometry- Absorption spectroscopy, merits and demerits, precautions.
4. SSAC Soil analysis-Objectives-Sampling of soil, procedure and precautions - Advantages and limitations.

5. SSAC Soil texture determination-Importance of soil texture for plant growth-Stokes law, derivation and limitations- Soil structure determination - Mean weight diameter of aggregates-Bulk density, porosity,
6. SSAC Soil air, importance, composition, characterization of soil aeration-ODR-Soil temperature, importance, measurement-Diurnal variation of soil temperature at different soil depths.
7. SSAC Interpretation of analytical data viz., pH, EC, Organic carbon- N, P, K, S and micronutrients (Fe, Mn, Zn, Cu, B) - Nutrient index. Soil texture, structure, aeration, soil temperature and their relative optimum value.
8. SSAC Plant analysis - Sampling stages and plant part to be sampled in various agricultural and horticultural crops.
9. SSAC Analysis of nutrients- Quantitative rating of plant analysis data and interpretation of results-Critical nutrient concentration-Critical nutrient ranges.
10. SSAC DRIS, nutrient ratios, DRIS chart-Benefits and limitations.
11. SSAC Water analysis- Quality criteria-Classification and Suitability of irrigation water - Water quality index.
12. SSAC Use of soil testing kit for major and micronutrient analysis.
13. CPHY Floral biology antithesis pollination- Fertilization, seed formation, filling, -Physiological maturity and harvest maturity of field crops.
14. CPHY Physiological and biochemical-Metabolic process during seed development and transformation- Seed morphological features.
15. CPHY Seed structures- Composition and functional components of seed- Seed vigour and seedling vigour.
16. CPHY Seed quality and its significance on crop productivity -Germination - Physical purity, genetic purity- Seed health & moisture content assessment and prescribed standards.

### Practicals

1. SSAC Standardization of solutions and reagents, acid base titrations
2. SSAC Collection and preparation of soil samples
3. SSAC Estimation of soil pH and EC
4. SSAC Estimation of soil organic carbon, qualitative & quantitative
5. SSAC Estimation of available soil nitrogen by Subbiah & Asija method
6. SSAC Estimation of available soil phosphorus by Olsens method and Brays & Kurtz method
7. SSAC Estimation of available soil potassium by flame photometer method
8. SSAC Estimation of soil sulphur by turbidity method
9. SSAC Estimation of soil micronutrients by AAS
10. SSAC Estimation of CEC and exchangeable sodium in soil

11. SSAC Determination of EC and pH of saturation extract/paste
12. SSAC Estimation of cations and anions
13. SSAC Plant sampling and sample preparation for analysis, study of soil biota.
14. SSAC Digestion of plant material
15. SSAC Estimation of N in plant sample
16. SSAC Estimation of P in plant sample
17. SSAC Estimation of K in plant sample
18. SSAC Rapid plant tissue test for N, P, and K
19. SSAC Collection of irrigation water sample and Determination of EC and pH of irrigation water
20. SSAC Estimation of Ca & Mg in Irrigation water
21. SSAC Estimation of carbonates and bicarbonates in Irrigation water
22. SSAC Estimation of chlorides in Irrigation water
23. SSAC Estimation of sodium in irrigation water and computation of SAR and RSC.
24. CPHY Floral biology of cereals , millets and pulse crops.
25. CPHY Floral biology of oil seed and fibre crops.
26. CPHY Description of seed structures, composition and economic importance of cereals- Millets, pulses, fibre crops & oil seed crops.
27. CPHY Physical purity test – Purification of seeds, inert matter, weed seeds, other crop seeds
28. CPHY Genetic purity- ODV test of self pollinated crops (Paddy, greengram, black gram, groundnut etc.,)
29. CPHY Growout test for hybrids of Cotton, Castor, Sunflower, Sorghum, Bazra
30. CPHY Determination of moisture by destructive analysis (Oven method  $P_2O_5$  \_phosphorous penta-oxide) Non destructive analysis with equipment.
31. CPHY Seed health – Seed Borne diseases & total fungal colonies determination by examination of dry seed, blotting paper method, sodium hydroxide etc
32. CPHY Normal seedlings abnormal seedlings, FUC/Hard seeds dead seeds, declaration of results, prescribe standards / sub standards

## References

1. Das, D.K. 2014. *Introductory Soil Science*, Kalyani Publishers, New Delhi
2. Tandon, H.L.S. 2013. *Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures*. Fertilizer Development and Consultation Organization, New Delhi

3. Chopra, S.L and Kanwar, J.S. 2010. *Analytical Agricultural Chemistry*. Kalyani Publishers, New Delhi
4. *Soil Test Based Fertilizer Application*. 2007 AICRP on STCR, ANGRAU, Hyderabad
5. Indian Society of Soil Science. 2015. *Soil Science – An Introduction*. IARI, New Delhi

**ELCT 272**

**FOOD SAFETY ISSUES**

**3(2+1)**

**Course outlines**

**Theory**

Food Safety - Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Types of hazards - Biological, Chemical, Physical hazards. Management of hazards - Need. Control of parameters. Temperature control. Food storage. Product 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 Tools- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP. ISO series. TQM - concept and need for quality, components of TQM, Kaizen. Risk Analysis. Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygiene. Food laws and Standards- Indian Food Regulatory Regime, FSSA. Global Scenario CAC. Other laws and standards related to food. Recent concerns- New and Emerging Pathogens. Packaging, Product labeling and Nutritional labeling. Genetically modified foods\ transgenics. Organic foods. Newer approaches to food safety. Recent Outbreaks.

**Practical**

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

**Lecture outlines**

**Theory**

1. Introduction to concepts of food safety, food quality, food quality management; objectives, importance and functions of quality control.
2. Factors affecting food safety, importance and significance of microorganisms in food safety, intrinsic and extrinsic factors affecting the growth of microorganisms in food.
3. Hazards and risks, types of hazards - Biological, chemical, physical hazards- Factors contributing to physical, chemical and biological contamination in food chain; Management hazards- Need.

4. Control of parameters. Preservation unit operations - Temperature control: Pasteurization– Basic concept,, pasteurization of unpackaged and packaged foods, effects of pasteurization on foods.; Evaporation – Main functions of evaporation, evaporation equipments. Dehydration – Objectives of dehydration, dehydration terminology, dehydration systems.
5. Preservation unit operation (low temperature operations) - Refrigeration, freezing and freeze drying.
6. Definition and regulation of food sanitation - Sources of contamination - Personal hygiene - Food handlers, cleaning compounds, sanitation methods, waste disposal strategy ( solid and liquid waste) and pest control.
7. Food preservation and processing their principles, methodology and technology.
8. Protection and preservation of foods - Hurdle technology, chemical, modified atmosphere, irradiation, thermal and non- thermal techniques.
9. Product design: Concept of product development - Product success and failure, factors for success, process of product development, managing for product's success. Innovation strategy - Possibilities for innovation, building up strategy, product development programme.
10. Food storage - Storage structures – Maintenance – Storage pests & their management.
11. Hygiene and sanitation in food Service establishments- Introduction - Sources of contamination and their control - Waste Disposal - Pest and rodent control - Personnel Hygiene.
12. Hygiene and sanitation in food service establishments- Food safety measures - Food Safety Management Tools- Basic concepts.
13. Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Agricultural Practice (GAP), Good Veterinary Practice (GVP), Storage and distribution of food, sanitation and safety in food services.
14. Hazard Analysis Critical Control Point (HACCP)- History, structure, pre- requites and principles, HACCP applications, HACCP based SOPs.
15. International Organization of Standardization (ISO)- Overview, structure, interpretation and case studies of food safety and quality management including ISO-22000, ISO-9001:2000, ISO22000:2005, ISO 17025/CODES/GLP, Retailers standards: BRC food and BRC IOP standards, IFS, SQF: 1000, SQF: 2000.
16. Recent concerns, new and emerging food pathogens.
17. Food surveillance: International and national practices, procedure and protocols, food alerts, traceability and food product recall.
18. Principles of food quality assurance, total quality management (TQM) – Good manufacturing/management practices, good hygienic practices, good lab practices, general awareness and role of management practices in quality control.

19. Continuous Improvement (Kaizen)- The three pillars of Kaizen – 1. Housekeeping  
2. Waste elimination - Seven Typical Wastes in Production Systems 3. Standardization - Improvement – Team work approach - Implementation – Kaizen and successful applications.
20. Risk Identification and analysis- Identify risky events, measure the element of risk, and develop responses to high-risk events.
21. Principal aspects of sampling of food: Importance of sample collection, sampling tools and containers, sample collection techniques.
22. Water analysis- Sampling – sampling frequency – storage of samples – Organoleptic and physical parameters – Chemical parameters – Methods of microbial analysis.
23. Inspection of food establishments, manufacturing units - Food regulatory enforcement and compliance through inspection - Inspectional requirements for food business operators - General inspection procedures, biological inspection of establishments.
24. Model Accreditation Standards- Introduction – Scope – Definitions – Legal authority – Certification authority – Capacity competence – Management and audit agency competence – Audit agent evaluation and monitoring – Quality assurance - Regulatory audit report.
25. Food safety standards of packaging and labelling regulations- packaging - General requirements, product specific requirements. Food packaging materials rigid and flexible such as plastic films, metal containers, glass, containers, paper and cardboard containers, jute containers, etc.
26. Product labelling and nutritional labeling.
- 27 & 28. Food Laws and Standards in India- a. Food Safety and Standards (FSS) Act, 2006, FSS Rules and Regulations, 2011. b. Agricultural Produce Act, 1937 (Grading and Marketing) c. Sugar (Control), Order, d. Export (Quality Control & Inspection), Act, 1963 and Rules e. Bureau of Indian Standards. f. Legal Metrology g. International Food Control Systems including CODEX.
29. Codex Alimentarius Commission (CODEX)- Introduction, standards, codex of practice, guidelines and recommendations, applying codex standards, Codex India, core functions of National Codex Contact Point, National Codex Committee of India.
30. Global Scenario CAC. Other laws and standards related to food.
31. Genetically modified foods\ transgenics.
32. Organic foods - Newer approaches to food safety - Recent Outbreaks.

## Practical

1. Water quality analysis - Physicochemical: Determination of Temperature, pH, turbidity, odour, colour, taste, pH, conductivity, TDS, TS, TSS, chloride and total alkalinity
- 2 & 3. Water quality analysis - Minerals: Determination of elements – Aluminium, Boron, Magnesium and Zinc
- 4 to 7. Water quality analysis - Minerals: Determination of Elements – Copper, Iron, Lead, Arsenic, Nickel and Cadmium.
8. Water quality analysis - Chemical: Determination of dissolved oxygen, nitrate levels in drinking water samples.
9. Water quality analysis - Microbiological analyses : Salmonella and *E. coli*.
10. Preparation of different types of media: Nutrient broth, nutrient agar, blood agar etc.
11. Microscopic examination of bacteria, and yeast and molds- Standard platecount; yeast and mould count; Spore count.
12. Microbiological examination of different food samples- Evaluation of microbiological quality of cereals, grains, fruits and vegetables.
13. Assessment of surface sanitation by swab/rinse method - Assessment of personal hygiene.
14. Biochemical tests for identification of bacteria.
15. Scheme for the detection of food borne pathogens.
16. Preparation of plans for implementation of FSMS - HACCP, ISO: 22000 - Establish a HACCP team - Describe the product - Identify the product's intended use - Draw up the commodity flow diagram - On site confirmation of flow diagram - Identify and analyse hazard(s) - Determine the critical control points - Establish a monitoring procedure - Establish corrective action - Verify the HACCP plan - Keep record.

## References

Inteaz Alli.2004. *Food Quality Italics Assurance : Principles and Practices*. CRC Press, Boca Raton, Ronald, H. Schmidt and Gary E. Rodrick. 2003. *Food Safety Handbook*. John Wiley & Sons, Inc., Hoboken. New Jersey, USA

Hester, R.E. and Harrison R.M. 2001. *Food Safety and Food Quality*. Royal Society of Chemistry, Cambridge, UK.

Michael, M. Cramer. 2013. *Food Plant Sanitation : Design, Maintenance, and Good Manufacturing Practices*. CRC Press, Boca Raton, FL, USA.

Norman, G. Marriott, and Robert, B. Gravani. 2006. *Principles of Food Sanitation*, 5<sup>th</sup> Ed. Springer Science+Business Media, Inc., NY, USA.

Hui, Y.H. Bernard L. Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong and Phil Ventresca. 2003. *Food Plant Sanitation*. Marcel Dekker, Inc., NY, USA.

Singh, B.D. 2014. *Biotechnology - Expanding Horizons*. Kalyani Publishers, New Delhi.

Pepper I.L. and Gerba C.P. 2005. *Environmental Microbiology*. Laboratory Manual, 2nd Ed. Elsevier Academic Press, Amsterdam.

**ELCT 283**

**HI-TECH HORTICULTURE**

**3 (2+1)**

### **Course outlines**

#### **Theory**

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

#### **Theory**

1. Hi-tech horticulture – Introduction - Scope and importance – Perspectives of Hi-tech horticulture in India.
2. Nursery management – Quality control of planting material- Plastics in nursery management – Advantages of plant propagation under green houses (Hi-tech nursery).
3. Mechanization – Importance of mechanisation in Hi-tech horticulture – Mechanisation of nursery, sowing and transplanting, plastic mulching, irrigation, fertigation, pest and disease control, weed control, harvesting etc.
- 4 & 5. Micro propagation of horticultural crops – Meristem culture - Various approaches of shoot multiplication – Applications of micro propagation – Problems in micropropagation - Advantages and limitations – Micro-grafting.
6. Modern field preparation methods – Raised bed preparation – Plastic mulching.
7. Modern planting methods – Container planting - Soil less culture – Hydroponics, aeroponics.
8. Protected cultivation- Advantages- Types of protected structures - Glass house, poly house, rain shelters, poly tunnels, hotbeds and cold frames, shade nets etc.

- 9&10. Greenhouse – Advantages- Controlled conditions – Light, Humidity, Temperature, CO<sub>2</sub> - Ventilation and cooling in a green house – Naturally ventilated, fan and pad cooling, forced air cooling etc. – Relative humidity, carbon-di-oxide level.
- 11 & Micro irrigation systems and its components – Methods of micro irrigation
12. (Surface drip, sub-surface drip irrigation, Bubblers, micro sprinkler etc.) - Maintenance of micro irrigation system.
- 13 Fertigation – Advantages –Limitations - Method of fertilizer injection ( Fertilizer injection system, Pressure differential injection system, Venturi injection system) – Selection of fertilizers – Solid fertilizers & liquid fertilizers.
- 14 EC, pH based fertilizer scheduling – Site specific nutrient management – Advantages and disadvantages.
- 15 & Canopy management – Importance of canopy management- principles of canopy
16. management – Tools of canopy management (Rootstocks, plant density, training and pruning, nutrient management, growth retardants etc.).
- 17 & High Density orcharding – Concept – HDP systems – Components of HDP (use of
18. genetically dwarf scion cultivars, dwarf rootstocks, pruning and training, use of growth retardants, induction of viral infection, use of incompatible rootstocks etc.) – Impact of HDP- Advantages- Constraints in HDP.
- 19 Precision farming – Definition – Scope and status of precision farming in India- Perspectives and potentials of precision farming in India - Components of precision farming.
- 20 & Remote sensing – Role of remote sensing in precision farming - Application of
21. remote sensing in the field of horticulture.
- 22 Geographical Information System (GIS) – Role of GIS in precision farming.
- 23 & Differential Global Positioning System (DGPS) – GPS introduction - Types of GPS -
24. DGPS uses in Agriculture - Yield monitoring, field mapping, precision crop input application (fertilizers, pesticides, weedicides etc.).
- 26 & Variable Rate applicator (VRA) – Introduction – Variable rate application methods
27. – map based VRA and Sensor based VRA – VRA management zones – Seeding VRA, Weed control VRA, Lime VRA, Fertilizer VRA.
- 28 & Precision farming – Applications of precision farming in horticultural crops (fruits,
29. vegetables and ornamental crops) – Strategic approaches of precision technology for improvement of fruit production.
- 30 Mechanized harvesting of produce – Advantages and disadvantages of mechanical harvesting – Mechanical harvesters developed for different horticultural crops – Robots in harvesting.

- 31 & Green food production – Approaches – Biodynamic farming – Biodynamic preparations – Cosmic integration – Biodynamic calendar – Strategies for green food production.

### **Practical**

1. Types of polyhouses.
2. Shade net houses.
3. Intercultural operations.
4. Identification and application of tools and equipments.
5. Micro propagation.
6. Nursery raising in portrays.
7. Study of Micro-irrigation system and its components.
8. Problems of micro irrigation system.
9. Estimation of EC of soil and water.
10. Estimation of pH in soil and water.
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.

### **References**

1. Prasad, S. And Kumar, U. 2012. *Greenhouse Management of Horticultural Crops*. 2<sup>nd</sup> edition, Agribios publishers, New Delhi.
2. Singh, H.P., Singh, G., Samuel, J.C., and Pathak, R.K.. 2003. *Precision Farming in Horticulture*. NCPAH, MOA, PFDC, CISH, Lucknow
3. Srivasthava, K.K.. 2007. *Canopy Management of Fruit Crops*. International book distributing co., Lucknow
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**ELCT 305**

**AGRICULTURAL WASTE MANAGEMENT**

**3(2+1)**

### **Course outlines**

#### **Theory**

Introduction to agricultural waste management, Nature and characteristics of agricultural waste and their impact on the environment, Kinds of wastes, Classification,

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

### **Practical**

Collection and preparation of agricultural waste sample. Determination of pH, EC, CE<sub>c</sub>, heavy metals, BOD, COD, TSS, TDS, NH<sub>4</sub>, Total P, and dissolved reactive P. Nutrient status (N, P, K, secondary and micronutrients) analysis of agricultural waste. Waste management equipment operation, Maintenance and safety hazards, computer software and models. Survey of different agri waste from live-stock, dairy, poultry, food processing, fruit & vegetable and agri-chemicals, Preparation of compost, vermicomposting, biogas and analysis of compost.

### **Lecture outlines**

#### **Theory**

- 1 AGRO** Introduction to agricultural waste management: Definitions of agricultural waste, residues and agricultural waste management- Roles and responsibilities - Waste generation and types - Sources of wastes and their classification.
- 2 AGRO** Nature and characteristics of agricultural waste - Nature of agricultural waste - Definitions of waste characterization terms
- 3 AGRO** Impact of agricultural waste on the environment: Introduction- Major environment-related drivers for agriculture- Leaching of nutrients and eutrophication of waters- Water availability and increasing demand for water- Soil degradation and pollution- Greenhouse gas emissions to the air- Climate change
- 4 AGRO** Kinds of wastes–Problems of waste: List of wastes- Non-hazardous- Hazardous- Agricultural waste fibers
- 5 AGRO** Agricultural waste-Classification: Animal-tissue waste-Plant-tissue waste- Animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated off-site- Wastes from forestry- Agrochemical waste containing hazardous substances
- 6 SSAC** Role of soil and plants in waste management
- 7 AGRO** Sources of waste (Cropped fields): Field residues- Process residues
- 8 SSAC** Sources of waste in allied sectors of agriculture
- 9 AGRO** Sources of waste in agro based industries: Rapeseed cake (RS), orange peel (OP), wheat bran (WB), spirulina powder (S)- Sugarcane: Molasses, Peels

- 10 **AGRO** Sources of waste - Urban waste etc. and their management: Industrial effluents- Urban compost- Plastic- Sewage sludge- Municipal waste-Garbage
- 11 **AGRO** Impact of agricultural waste on soil quality – Mechanism of interaction of waste with soil: Definitions of soil fertility, soil productivity and soil quality- Effect of agricultural waste on soil physical and chemical properties-Mechanism of interaction of waste with soil- Soil degradation- On-farm management of crop residues- Effect of compost, FYM, green manures on soil quality
- 12 **SSAC** Impact of agricultural waste on plant quality
- 13&14 **SSAC** Biological processes of agricultural waste management
- 15 **AGRO** Utilization of Agricultural waste (Paddy, wheat, sugar cane, cotton and mustard waste): Livestock feed- Compost making- Energy source- Bio-fuel and bio-oil production- Biomethanation- Gasification- Biochar production- Utilization of sewage- Mulches
- 16 **AGRO** Recycling of Agricultural waste: Introduction- Significance of Recycling- Recyclable agricultural wastes- Methods of recycling- Incineration- Composting- Land application- Re feeding - Anaerobic digestion
- 17 **AGRO** Potential of recyclable crop residues and their management: Availability of crop residues-Waste generated from different crops- Crop residues management strategies in different countries- Managing crop residues with conservation agriculture
- 18 **AGRO** In-situ management of agriculture waste: Introduction- Waste management functions- Six basic functions: production, collection, storage, treatment, transfer, utilization- Waste management systems
- 19 **SSAC** Composting (Types of composting and their suitability for different situations)
- 20 **SSAC** Vermicomposting for bio- conservation of biodegradable waste
- 21 **SSAC** Biogas Technology
- 22 **SSAC** Agricultural waste ( influence on water resources)–Eutrophication
- 23 **SSAC** Agricultural waste ( influence on air resources) – Nitrous Oxide emissions and ammonia emissions from soil in relation to climate change effects
- 24 **AGRO** Agricultural waste ( influence on animal resources): Poultry waste- Goat and sheep waste- Penning- FYM
- 25 **AGRO** Impacts of waste on human, animal health and environment: Impacts of solid waste on health- Diseases- The role of plastics- Occupational hazards associated with waste handling-Effect of heavy metal on health of humans and animals
- 26 **AGRO** Effect of hazards wastes on environment- Surface water contamination- Groundwater contamination- Air contamination- Soil contamination
- 27 **AGRO** Management of bedding & litter in livestock management: Definitions- Types of bedding and litter materials- Case systems and types - Litter management

practices- Moisture- litter re utilization- Litter amendments- Acidifiers- Other amendments- Disposal and reuse

- 28 AGRO** Wasted feed (types of feed from different by- products of agriculture): Feed definition- Types of feeds- Different crop by- products used as feed- Nutrient concentrations in different by - products- Left over feed and their utilization
- 29 AGRO** Run-off from feed lots and holding areas and waste water from dairy parlors: Water use on dairy farms- Open lot run off quality- Nutrient content of runoff water from dairy farms- Causes of runoff from feed lots- Primary and secondary stage lagoons- Settling basin and primary lagoon
- 30 AGRO** Agro-waste recycling through farming system
- 31 AGRO** Waste management machineries: Introduction and scope- Selecting waste handling equipment- Waste production equipment- Waste collection equipment- Waste storage equipment- Waste treatment equipment- Waste transfer equipment- Waste utilization equipment
- 32 SSAC** Environmental benefit of waste management

### Practical

1. Collection and preparation of agricultural waste sample
2. Determination of pH, EC, CEC
3. Determination of heavy metals
4. Determination of BOD, COD, TSS
5. Determination of TDS,  $\text{NH}_4$
6. Determination of total P and dissolved reactive P
7. Analysis of nutrient status of N of agricultural waste
8. Analysis of nutrient status of P and K of agricultural waste
9. Analysis of nutrient status of secondary nutrients of agricultural waste
10. Analysis of nutrient status of micronutrients of agricultural waste
11. Waste management equipment operation
12. Maintenance and safety hazards, computer software and models
13. Survey of different agri-wastes from livestock, dairy and poultry
14. Survey of different agri-wastes from food processing, fruit and vegetable and agrichemicals
15. Preparation of compost, vermi composting and biogas
16. Analysis of compost

### References:

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2. Tandon, H.L.S.(ed.). 2009. *Recycling of crop, animal, human and industrial wastes*. Fertilizer Development and Consultation organisation, Newdelhi
3. Tandon, H.L.S.(ed.). 2009. *Soil health management*. Fertilizer Development and Consultation organisation, Newdelhi
4. Raymond C Loehr. 1974. *Agricultural waste management: problems, processes and approaches*. Academic Press

**ELCT 306**

**WEED MANAGEMENT**

**3(2+1)**

### **Course outline**

#### **Theory**

Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Herbicide classification, concept of adjuvant, surfactant, herbicide formulations and their use. Introduction to mode of action of herbicides and selectivity. Allelopathy and its application in weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with nutrients and their application. Integration of herbicides with non chemical methods of weed management. Herbicide resistance and its management.

#### **Practical**

Techniques of weed preservation. Weed identification and the losses due to weeds-study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and nutrient compatibility study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipments. Calculations of herbicide doses, weed control efficiency and weed index.

### **Lecture outlines**

#### **Theory**

1. Weed -Definition- Dimensions of the problem- Harmful and beneficial effects of weeds on different ecosystems
2. Classification of weeds based on morphology- Life cycle- Habitat-Origin-association- soil reaction and special features with examples
3. Reproduction in weeds-Sexual-Asexual-Vegetative propagation-Dissemination of weeds - Seeds and fruits-Mechanisms/agents
4. Weed biology-Ecology-Persistence of weeds-Climatic-Edaphic and Biotic factors-Characteristics of weeds
5. Crop-weed interference-Crop-weed association-Crop-weed competition-Principles-Factors affecting crop-weed competition
6. Critical period of crop-weed competition-Concept-Critical period of crop-weed competition for different field crops - Allelopathy and its role in weed management.

7. Methods of weed management–Prevention-Control-Eradication-Physical/mechanical- Cultural methods.
8. Biological weed control-Types of bioagents-Selection criteria-Outstanding examples Bioherbicides - Concept-Relative merits and limitations-Commercially available bioherbicides.
9. Herbicide-Definition-Advantages and limitations of herbicide usage in India-Nomenclature of herbicides-Herbicide label information-presently available herbicides in the market.
10. Classification of herbicides based on chemical nature and selectivity
11. Classification of herbicides based on time and method of application
12. Adjuvant- Definition –Types of adjuvants and their use in herbicide application
13. Herbicide formulation-Need for formulation-Types -Relative merits and demerits of each type of formulation
14. Mode of action of herbicides-Important biochemical modes of action of herbicides interfering with photosynthetic reactions, normal respiration-Growth and development
15. Mode of action of herbicides-Important biochemical mode of action of herbicides-Protein and nucleic acid synthesis inhibitors-Lipid synthesis inhibitors-Branched chain amino acid synthesis inhibitors-Aromatic compound biosynthesis inhibitors and other modes of action of herbicides
16. Herbicide selectivity-Fundamental principles of selectivity- Differential rate of absorption -Differential rate of translocation
17. Herbicide selectivity- Differential rate of deactivation-Metabolism-Reverse metabolism- Conjugation- Protoplasmic resistance and multifactor herbicide selectivity - Sublethal effects of herbicides on crop plants
18. Factors influencing herbicide selectivity- Dose-Time-Method of herbicide application- Herbicide drift and its management -Herbicide residues
19. Herbicide mixtures- Need- Types- Advantages and limitations of herbicide mixtures in agriculture
20. Herbicide compatibility with nutrients-Insecticide- Fungicides and other agrochemicals
21. IWM-Definition-Objectives-Advantages. Recent advances in non-chemical weed management-Stale seed bed-Soil solarization-Mulches- Brown manuring-Plant origin herbicides
22. Selection of herbicides–Criteria for selection of herbicide based on crop/cropping system-Weed flora-Soil type-Formulation and its cost *etc*
23. Weed management in different systems of rice cultures -Yield loss-Weed flora and time of occurrence-Nonchemical and chemical methods

24. Weed management in wheat, maize, jowar, bajra and other minor millets- Yield loss-Weed flora and time of occurrence-Nonchemical and chemical methods
25. Weed management in pulses; redgram, bengalgram- Yield loss-Weed flora and time of occurrence-Nonchemical and chemical methods
26. Weed management in groundnut, sunflower, soybean, sesame and castor- yield loss-weed flora and time of occurrence-nonchemical and chemical methods
27. Weed management in sugarcane, cotton, mesta and tobacco- Yield loss-weed flora and time of occurrence-Nonchemical and chemical methods
28. Weed management in onion, chillies, tomato and brinjal- yield loss-Weed flora and time of occurrence-nonchemical and chemical methods
29. Weed management in aquatic ecosystems- Water hyacinth – Typha – Ipomea – Algal weeds and their control
30. Management of weeds in non-cropped areas including problematic weeds
31. Management of parasitic weeds- Cuscuta- Striga- Orabanchi- Loranthus
32. Herbicide resistance in weeds- Reasons and its management-Herbicide resistant crops-Advantages and limitations

### **Practicals**

1. Techniques of weed preservation
2. Weed identification
3. Survey of weeds in different crop ecosystems.
4. Field study of crop-weed association and determination of critical period of crop-weed competition
5. Estimation of weed flora in different crops
6. Estimation of yield losses due to weeds in ongoing field experiments
7. Biology of important weeds in different ecosystems
8. Herbicide label information for different herbicides and mixtures
9. Study of herbicide and nutrient compatibility
10. Shift in weed flora in longterm field experiments
11. Participation in different methods of herbicide application and precautionary measures
12. Spraying equipments and their calibration for herbicide application
13. Calculations of herbicide doses
14. Study of phytotoxicity symptoms of herbicides in different crops
15. Calculations of weed control efficiency and weed index
16. Economic analysis of weed control practices in crops and cropping systems

## References

1. Gupta, O.P. 2012. *Modern Weed Management* (4<sup>th</sup> edition), Agrobios (India) Ltd, Jodhpur
2. Rao, V.S. 1992. *Principles of Weed Science* (2nd edition), Oxford & IBH Publishing Co. Pvt Ltd, New Delhi.
3. Ross, M.A and Lembi, C.A. 1999. *Applied Weed Science*. (2nd edition), Prentice Hall of India Pvt Ltd, New Delhi
4. Saraswat, V.N., Bhan, V.M. and Yaduraju, N.T. (eds.). 1998. *Weed management* –ICAR Publication.

**ELCT 315**

**COMMERCIAL PLANT BREEDING**

**3(1+2)**

### Course outlines

#### Theory

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

#### Practical

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

### Lecture outlines

#### Theory

1. Types of crops and modes of plant reproduction.

2. Line development and maintenance breeding in self and cross pollinated crops (A/B/R and two line system) for development of hybrids and seed production.
3. Genetic purity test of commercial hybrids.
- 4-11. Advances in hybrid seed production of rice, maize, sorghum, pearl millet, castor, sunflower, cotton and pigeonpea.
12. Quality seed production of vegetable crops under open and protected environment.
13. Alternative strategies for the development of the line and cultivars: haploid inducer, tissue culture techniques and biotechnological tools.
14. IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act.
15. Variety testing, release and notification systems in India.
16. Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

### **Practical**

- 1 & 2. Floral biology in self pollinated species and cross pollinated species.
3. Selfing techniques.
4. Crossing techniques.
- 5-7. Techniques of seed production in self and cross pollinated crops using A/B/R and two line system.
8. Learning techniques in hybrid seed production using male-sterility in field crops.
9. Understanding the difficulties in hybrid seed production.
10. Tools and techniques for optimizing hybrid seed production.
11. Concept of rouging in seed production plot.
12. Concept of line and its multiplication in hybrid seed production.
13. Line purification in hybrid seed production.
14. Role of pollinators in hybrid seed production.
- 15-24. Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeonpea, cotton and vegetable crops.
- 25 & 26. Sampling and analytical procedures for purity testing and detection of spurious seed.
27. Seed drying.
28. Seed storage structure in quality seed management.
- 29 & 30. Screening techniques during seed processing viz., grading and packaging.
- 31 & 32. Visit to public and private seed production and processing plants.

### **References**

1. Agarwal, R.L. 2015. *Seed Technology*. Oxford and IBH Publication Co., New Delhi.
2. Khare, Dharendra and Bhala, M.S. 2014. *Seed Technology second revised edition*. Scientific Publishers. Jodhpur.

3. Phundan Singh, 2014. *Essentials of Plant Breeding*. Kalyani Publishers, New Delhi.
4. Singh, B.D. 2015. *Plant Breeding: Principles and Methods*. Kalyani Publishers, New Delhi.

**ELCT 333**

**BIOPESTICIDES AND BIOFERTILIZERS**

**3(2+1)**

### **Course outlines**

#### **Theory**

History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides *viz.* pathogen, botanical pesticides, and biorationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogens. Methods of application of biopesticides. Methods of quality control and techniques of biopesticide evaluation. Impediments and limitation in production and use of biopesticide.

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

#### **Practical**

To study about mass production technology of important biopesticides. Identification of important botanicals. Visit to biopesticide lab. Working in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides.

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

### **Lecture outlines**

#### **Theory**

- 1 History and concept of biopesticides.
- 2 Importance, scope and potential of biopesticides
- 3 Definitions and classification of biopesticides

- 4 Biopesticides – Pathogens - Entomopathogenic bacteria- Classification - Spore forming – Crystalliferous and Non crystalliferous; Non spore forming, Mode of entry, Mode of action, Virulence, Pathogenicity and Symptoms - advantages and limitations
- 5 Biopesticides – Pathogens – Entomopathogenic viruses- Classification – Polyhedral Inclusion Bodies (Nucleo and Cytoplasmic); Granulovirus and Non inclusion virus - Mode of entry, Mode of action, Virulence, Pathogenicity and Symptoms, advantages and limitations
- 6 Biopesticides – Pathogens - Entomopathogenic fungi- Classification (fungi belonging to phyla, Zygomycota, Ascomycota and Deuteromycota), Mode of entry, Mode of action, Virulence, Pathogenicity and Symptoms, advantages and limitations.
- 7 Biopesticides – (Protozoa and EPN) Entomopathogenic Protozoa, Entomopathogenic Nematodes (Steinernematidae, Heterorhabditidae), Mode of entry, Mode of action, Virulence, Pathogenicity and Symptoms advantages and limitations
- 8 Biopesticides – Botanical pesticides – Plants having insecticidal properties viz., *Chrysanthemum*, Neem, *Pongamia*, Custard apple, *Derris*, Tobacco and sweet flag. Their active ingredients, mode of action, advantages and disadvantages
- 9 Biorationals – Insecticides from animals and other living organisms that have insecticidal properties and also safe to non-target organisms – Pheromones, Chitin synthesis inhibitors, Juvenile hormones and Male sterile technique.
- 10 Mass production technology of bio-pesticides- Entomopathogenic bacteria – *Bacillus thuringiensis*
- 11 Mass production technology of bio-pesticides- Entomopathogenic virus - NPV
- 12 Mass production technology of bio-pesticides- Entomopathogenic fungi - *Beauveria bassiana*, *Metarrhizium anisopliae* and *Nomuraea rileyi*
- 13 Mass production technology of bio-pesticides- Entomopathogenic protozoa and EPN (*Steinernema carpocapsae* and *Heterorhabditis bacteriophora*)
- 14 Formulations- Wettable powders and Liquids - Methods of application of biopesticides - Foliar and Dust application
- 15 Methods of quality control and techniques of bio pesticide evaluation (Quantification of virus load in case of NPV (PIBs), Haemocytometer ; CFU count for Entomopathogenic fungi etc.,
- 16 Impediments or limitations in mass production and use of biopesticides
- 17 Introduction, status and scope of bio fertilizers
- 18 Structure and characteristic features of bacterial biofertilizers
- 19 *Rhizobium*-prerequisites for infection, nodulation process and biochemistry of nitrogen fixation

- 20 Cross inoculation groups of Rhizobium
- 21 *Azotobacter*-Characteristics, their significance and utilization in agriculture
- 22 *Azospirillum*- Occurance, Characteristics, its significance and utilization in agriculture
- 23 Mechanism of phosphate solubilization: PSB *Bacillus* & *Pseudomonas* - Their significance and utilization in agriculture K solubilization-Microorganisms involved and their utilization
- 24 Actinorrhizal Symbiotic N<sub>2</sub> fixer-*Frankia*
- 25 Cyanobacterial biofertilizers- *Anabaena*, *Nostoc*, *Hapalosiphon*
- 26 Fungal biofertilizers- AM mycorrhiza and ectomycorrhiza
- 27 Nitrogen fixation -Free living and symbiotic nitrogen fixation
- 28 Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertilizers
- 29 FCO specifications and quality control of biofertilizers
- 30 Application technology of bio fertilizers for seeds, seedlings, tubers, sets etc
- 31 Biofertilizers- Storage, shelf life, quality control (Plant infection test) and marketing of biofertilizers
- 32 Factors influencing the efficacy of biofertilizers

### **Practical**

- 1 Study on preparation or mass production technology of important biopesticides – bacteria *Bacillus thuringiensis*
- 2 Study on preparation or mass production technology of important biopesticides – Entomopathogenic virus - *SI NPV* and *Ha NPV*
- 3 Study of mass production technology of important biopesticides – Entomopathogenic fungi - *Beauveria bassiana*, *Metarhizium anisopliae*, *Nomuraea rileyi*
- 4 Study of mass production technology of important biopesticides – EPN (*Steinernema carpocapsae*); Isolation and identification of soil borne EPNs (*Galleria* larval bait/trap technique)
- 5 Identification and preparation of important botanical insecticides (NSKE; Tobacco decoction, *Pongamia* and *Annona* leaf extracts)
- 6 Visit to nearby biopesticide laboratory.
- 7 Field visit to explore naturally infected cadavers of Bt, Virus, Fungus.
- 8 Identification of potential entomopathogenic entities in the field - from soil and plants & Studies on quality control of biopesticides
- 9 Isolation of *Rhizobium* from soil and root nodules
- 10 Isolation and purification of *Azospirillum* and *Azotobacter* from rhizosphere soil

- 11 Isolation and purification of P and K solubilizers from rhizosphere soil
- 12 Mass production technology of BGA (Blue Green Algae)
- 13 Production Technology of *Azolla*
- 14 Isolation of and purification of VAM (Vascular Arbuscular Mycorrhiza) fungi from rhizosphere soil by wet sieving and decantation and sucrose gradient method
- 15 Mass multiplication and inoculums production of biofertilizers
- 16 Quality assessment of different biofertilizers (both carrier and liquid based) including plant infection test

## References

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**ELCT 334**

**AGROCHEMICALS**

**3(2+1)**

## 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 copperoxychloride.

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 of insecticides: inorganic and organic insecticides - Organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids Neonicotinoids, Biorationals, Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil & plant. IGRs Biopesticides,

Reduced risk insecticides, Botanicals, 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- Manufacturing of ammonium phosphates, nitrophosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing.

Plant bio-pesticides for ecological agriculture, Bio-insect repellent.

### **Practical**

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

### **Lecture outlines**

#### **Theory:**

- 1 Agro An introduction to agrochemicals, their type and role in agriculture,
- 2 Agro 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 – Classification of herbicides based on chemical nature, time and method of application
- 4 Agro Herbicides-Major classes, properties and important herbicides. Fate of herbicides.
- 5 Pl Path Fungicides– Classification – Based on movement in plant, based on application methodology, based on mode of action, based on chemical nature, based on utility (against lower fungi, powdery mildews, rusts, smuts, coloured fungi etc.

- 6 & 7PI Path Inorganic fungicides- Characteristics, preparation and use of sulphur and copper fungicides, Mode of action-Bordeaux mixture, copper oxychlorid and sulphur fungicides
- 8 PI Path Organic sulphur fungicides- Mode of action-Dithio carbamates-characteristics, preparation and use of Zineb and Maneb.
- 9 PI Path Systemic fungicides- Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, Triazoles, Strobilurins characteristics and use.
- 10 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.,
- 11 Ento Organochlorines- Synthetic organic insecticides – Chlorinated hydrocarbons – Dichloro Diphenyl Trichloroethane (DDT) and Hexacholoro Cyclo Hexane (HCH). Cyclodiens - Aldrin, dieldrin, heptachlor and endosulfan - Toxicity and mode of action.
- 12 Ento Organo phosphates - Systemic, non-systemic and translaminar action of insecticides with examples – Brief mode of action – Toxicity, formulations and uses of malathion, methyl parathion, diazinon, dichlorvos, fenitrothion, quinalphos, phosalone, chlorpyriphos, phosphomidon, monocrotophos, methyl demeton, dimethoate, triazophos, profenophos, acephate and phorate
- 13 Ento Carbamates - Mode of action – Toxicity, formulations and uses of carbaryl, propoxur, carbofuran, aldicarb and methomyl -
- 14 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.
- 15 Ento -Insecticides of other groups - Nicotinoid insecticides - Brief mode of action – Toxicity, formulations and uses of imidacloprid, acetamiprid, thiamethoxam and clothianidin.
- 16 Ento Biorationals - Brief mode of action, toxicity, formulations and use - Phenyl pyrazoles, fipronil - Macro cyclic lactones –Spinosyns - Sainosad; 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
- 17 Ento IGRs- Brief mode of action - Toxicity, formulations and use- Chitin synthesis inhibitors - Diflubenzuron, Flufenoxuron, Chlorfluazuron, 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.

- 18 Ento Biopesticides and reduced risk insecticides- Plant bio-pesticides for ecological agriculture, Botanicals, Bio-insect repellent,
- 19 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.
- 20 Ento Recent advances in pest control- Repellents (physical and chemical) and antifeedants - Importance of antifeedants and limitations of their use – attractants - Sex pheromones - List of synthetic sex pheromones - Use in IPM - Insect hormones – Gamma irradiation – Genetic control – Sterile male technique.
- 21 SSAC Fertilizers and their importance -Classification with examples-Nitrogenous fertilizers- Feed stocks-Manufacturing process and properties of Ammonium sulphate, ammonium nitrate
- 22 SSAC Manufacturing process and properties of ammonium chloride and urea-Slow release nitrogenous fertilizers
- 23 SSAC Phosphatic fertilizers-Uses-Types and properties - Manufacturing process and properties of SSP, TSP, bone meal and basic slag
- 24 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 soils
- 25 SSAC Mixed and complex fertilizers-Sources - Advantages and disadvantages over straight fertilizers - Compatability of fertilizers - Physical problems and chemical problems associated with bulk blended fertilizers - Problems on formulation of fertilizer mixtures
- 26 & 27SSAC Manufacturing process and properties of Ammonium phosphate, Urea - Ammonium phosphate and Ammonium Sulphate Nitrate and Ammonium Polyphosphates- Nitrate phosphates and NPK complexes
- 28 SSAC Secondary and multinutrient fertilizers- Different sources of nutrients and their contents-Conditions leading to their deficiency.
- 29 SSAC Fertilizer Storage- Introduction-Common problems during storage-Caking - Dustiness-Chemical compatability-Corrosivity
- 30 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.
- 31 SSAC Fertilizer Control Order (FCO)-Importance and regulations-Specifications-and fertilizer storage standards of important fertilizers.

- 32 SSAC Fertilizer logistics and marketing- Introduction-Organisational setup and Functions - Development and growth of fertilizer industry- Movement of major fertilizers – Measures of support for fertilizer sector Public Sector Undertakings-Fertilizer Monitoring System-Vigilance Activities

### Practical

- 1 Agro Sampling of fertilizers and pesticides (Insecticides/fungicides/herbicides).
- 2 Agro Study and identify various fertilizers & formulations of herbicides available in market and calculation of doses of fertilizers and herbicides.
- 3 Ento Study and identify various formulations of insecticides available in market
- 4 Ento Calculation of doses of insecticides.
- 5 Ento Pesticides application technology to study about various pesticides appliances.
- 6 PI Path Study and identify various formulations of fungicides available in market
- 7 PI Path Calculation of concentrations and doses of fungicides.
- 8 SSAC Sampling of fertilizers and pesticides for chemical analysis.
- 9 SSAC Quick tests for identification of common fertilizers
- 10 SSAC Identification of anions and cations in unknown fertilizer
- 11 SSAC Estimation of nitrogen in Urea.
- 12 SSAC Estimation of water soluble  $P_2O_5$  and citrate soluble  $P_2O_5$  in Single Super Phosphate by Pemberton's method
- 13 SSAC Estimation of potassium in MOP/SOP by flame photometer method.
- 14 SSAC Determination of copper content in Copper Oxychloride
- 15 SSAC Determination of sulphur content in Sulphur fungicide (elemental sulphur).
- 16 SSAC Determination of purity of Thiram and Ziram Market Survey of Agrochemicals.

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11. HCL Gupta. 1999. *Insecticides Toxicology & Uses*. Agrotech Publishing Academy, Udaipur

**ELCT 342**

**AGRIBUSINESS MANAGEMENT**

**3 (2+1)**

### **Course outlines**

#### **Theory**

Management- concepts and functions, Agribusiness Management-Scope, Structure, importance and its role in the Indian economy, Concepts of agribusiness, Production management, Marketing management, Financial management, SWOT analysis— concept and its application in agribusiness enterprises, Agro-based industries and their linkages, contribution of agro- industries to the economy, Agribusiness Projects Evaluation - concepts project cycle, appraisal and evaluation techniques, sensitivity analysis. – Basic guidelines for preparation of project reports.

#### **Practical**

Balance sheet analysis and Analysis of Profit and Loss statement, Break Even Analysis/ Cost –Volume-n Profit analysis, Financial Ratio Analysis, Development of Business performance tracking system, Compounding and Discounting Techniques, Project Appraisal Techniques, Preparing Business plans, SWOT Analysis, Visit & Study of Profile of Agro-based industries, Formulation of project feasibility report of agribusiness enterprise, Marketing management of agribusiness enterprise.

### **Lecture outlines**

#### **Theory**

1. Agribusiness – Meaning, scope and structure and dimensions (Agricultural input sector - Agricultural production sector - Agricultural processing sector and Marketing and trade sector) - Importance of agribusiness in Indian economy, - Distinctive features of agribusiness
2. Management – Definitions and concepts - Pipeline diagram - Agribusiness Management – Meaning and definitions and salient features.
3. & 4. Management functions – Wheel diagram, planning, its importance - Types of plans - Structure of planning - Goals or objectives - Strategies, policies,

- procedures, rules, programmes – Characteristics of good plan - Steps in planning.
5. Organizing– Meaning, purpose, staffing – Definition - Staffing process.
  6. & 7. Directing – Motivation – Ordering – Leading – Supervision, coordination, communication and control – Meaning and definitions, purpose.
  8. Decision making – Organizational culture – Management of organizational conflicts – Managing change – Leadership styles – Group dynamics – Motivation.
  9. Managing human resources in agribusinesses - HR Functions - Role of HR managers – Human resource planning.
  10. Human resource training and development – Participative management, labour management relations, conflict management.
  - 11,12 & 13 Production management - Production, plant layout and material handling, operations planning and control - Inventory management - Inventory – Meaning – Definition – Objectives of inventories - Quality management production control – Scheduling methods (Net working methods – PERT & CPM) - Quality control
  - 14.& 15 Marketing management in agribusiness – New product development, consumer behavior and the buying process.
  - 16.&17 Developing marketing strategies - Four P's of marketing and planning, marketing mix.
  18. Market segmentation - Meaning, types, and importance.
  19. Product concept – Product line and mix - Branding agricultural products.
  20. Packaging, its functions - Physical distribution.
  21. &22 Selling, advertising, marketing research, marketing extension, rural retailing supply chain management for agribusiness.
  23. Capital management in agribusiness – Fixed capital and working capital - Meaning, types, operating cycle and working capital importance.
  - 24.&25 Financial management – Importance of financial statements – Balance sheet and profit and loss statement, cash flow statement - Meaning, components and formats of financial statements.
  - 26 Analyzing financial statements – Liquidity ratios – Leverage ratios – Activity ratios – Turnover ratios – Profitability ratios
  27. Strategic management – Meaning, concept and scope – External and internal environmental factors influencing strategy – Scanning the external and internal environment – Strategy formulation - SWOT analysis of agribusiness enterprise.
  28. Agro based industries – Importance, need – Institutional arrangements for the promotion of agro-based industries – Procedure to be followed to set up agro-based industries – Constraints in establishing agro-based industries.
  29. &30. Project – Meaning – Definition – Project cycle – Guidelines for preparation of project reports.

31.& 32. Project appraisal and evaluation techniques – Undiscounted measures and decision rules - PBP ROR, and discounted measures and decision rules – NPW, BCR, IRR, N/K ratio, Sensitivity analysis.

### **Practical**

1. Balance sheet analysis.
2. Analysis of profit and loss statement.
3. Break even analysis/ Cost volume profit analysis.
- 4.& 5. Financial ratio analysis.
6. Development of business performance tracking system.
7. Compounding and discounting techniques.
8. Project appraisal techniques – I Undiscounted measures -PBP, ROR
- 9 &10. Project appraisal techniques – II Discounted measures NPW, BCR
- 11 &12. Project appraisal techniques – III - IRR N/K Ratio & PI and sensitivity analysis
13. Preparing business plans.
14. Case study -1 : Visit and study of profile of Agro-based industries.
- 15 &16. Case study -2: Formulation of project feasibility report of agribusiness enterprise.

### **References**

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7. Pandey, I M. *Financial management*
8. Philip Kotler, Kevin Lane Keller, Abraham Koshy and Mithileswar Jha. 2009. *Marketing Management: A South Asian Perspective*. International 13<sup>th</sup> edition. Pearson Prentice Hall.

**Course outlines****Theory**

Meaning and concept of *in vitro* culture and micro-propagation; Historical milestones, advancement and future prospects of micro propagation; totipotency, dedifferentiation; Tissue culture methodology: Sterile techniques, synthetic and natural media components, growth regulators, environmental requirement, genetic control of regeneration; Plant regeneration pathways-Organogenesis and Somatic embryogenesis; Micro-propagation – Definition, methods, stages of micro-propagation and its significance; Axillary bud proliferation approach – Shoot tip and meristem culture; Organogenesis-Purpose, methods and requirements for organogenesis, indirect and direct organogenesis; Somatic embryo genesis – Procedures and requirements for organogenesis, indirect and direct embryogenesis; Differences between somatic and gametic embryogenesis, Synthetic seed- Concepts, necessity, procedure and requirements for production of synthetic seeds.

**Practical**

Laboratory organization, Sterilization techniques for explants, glassware, plasticwares, labwares and working platform. Preparation of stocks and working solution. Preparation and sterilization of growth regulators. Preparation of working medium and Experimentation on determining optimum concentration of growth regulators. Callus induction and regeneration of whole plants from different parts of plants. Direct regeneration into whole plants using bud, node and other tissues. Induction of somatic embryos. Experiments of synthetic seeds production and testing storability and germination efficiency.

**Lecture outlines****Theory**

- 1 Meaning and concept of *in vitro* culture, micropropagation, totipotency, dedifferentiation, Historical milestones in tissue culture techniques.
- 2 Applications, advantages and limitations of tissue culture techniques.
- 3 & 4 Tissue culture methodology – Different types of media - Environmental requirements of tissue culture unit – Techniques of sterilization/ asepsis for glass and metal ware, liquids both thermostable and thermolabile, disposal of remnants of culture.
- 5& 6 Components of the tissue culture media – Inorganic nutrients, vitamins, amino acids and other organic supplements, carbon source, hormones/ plant growth regulators, pH of the media, gelling agents.
6. Components of the tissue culture media - Carbon source, hormones/ plant growth regulators, pH of the media, gelling agents.
7. Preparation of media – Stocks and working media, preparation and storage.
8. Genetic control of regeneration.

- 9 & 10 Pathways of regeneration of plants – Organogenesis direct and indirect and factors affecting organogenesis – Somatic embryogenesis and factors affecting somatic embryogenesis - Differences between gametic and somatic embryos.
- 11 to 14 Synthetic seeds – Concept, necessity, procedure and requirements of synthetic seeds Clonal propagation – Definition, stages of micropropagation- Auxillary bud proliferation, shoot tip and meristem culture –Factors affecting micropropagation –Applications and limitations.
- 15& 16 Advancements and future prospects of *in vitro* culture – Techniques of single cell culture, suspension cultures - Selection of somaclonal variants for crop improvement –Advancements and future prospects *in vitro* culture – Production of secondary metabolites through cell culture techniques.

### Practical

- 1-2 Organization of tissue culture laboratory.
- 3-4. Sterilization techniques used in tissue culture laboratory – Glass, plastic and metal ware.
- 5-6. Study and use of laminar flow unit for tissue culture.
- 7-8. Study and use of autoclaves for tissue culture.
- 9-10. Preparation of stock and working solutions of tissue culture media.
- 11-12 Sterilization techniques used in tissue culture laboratory – Media, hormones and other thermolabile compounds (Filter sterilization).
- 13-14. Preparation and inoculation of explants for direct organogenesis – Shoot tip, nodal explants.
- 15-16. Preparation and inoculation of explants for callus production – Leaf, stem and root explants.
- 17-18 Determination of optimum concentration of hormones/ growth regulators for direct organogenesis – Shoots.
- 19-20. Determination of optimum concentration of hormones/ growth regulators for direct organogenesis – Roots.
- 21-22. Sub culturing for multiple shoots and calli produced *in vitro*.
- 23-24. Determination of optimum concentration of auxins to generate shoots from *in vitro* generated calli.
- 25-26. Production of somatic embryos *in vitro* in carrot.
- 27-28. Identification of different stages / phases of somatic embryos.
- 29-30. Preparation of synthetic seeds from somatic embryos.
- 31-32. Storage and germination of synthetic seeds.

### References

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2. Keshavachandran, R. and Peter, K.V. 2008. *Pant Biotechnology: Methods in Tissue Culture and Gene Transfer*. Universities Press, Hyderabad.

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**ELCT 382**

**LANDSCAPING**

**3 (2+1)**

### **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 applications.

#### **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 lath house. Use of computer software, visit to important gardens/parks/ institutes.

#### **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 – Contract – Harmony – Vista – Style.
3. Garden types- Formal - Informal – Wild Garden - Styles of garden in the world- Mughal Garden- Site and design – Walls and gates – Terrace- Running water- Baradari- Trees and flowers.

4. Features of English – Italian – French – Persian Gardens – Japanese Garden – Types of Japanese Garden – Hill – Flat – Tea – Passage – Sand Gardens.
5. Features of Japanese Garden – Ponds – Streams – Waterfalls – Fountains – Islands – Bridges – Water Basins – Stone Lanterns – Stones – Pagodas – Fences and Gates – Vegetation (Ever green, Deciduous and Flowering plants).
6. Famous Gardens of India –Lal bagh (Bangalore) – Brindavan Garden (Mysore) – Government Botanic Gardens (Ootacamud) Mughal garden (Pinjore) – Chandigarh Rose garden.
7. Terrace gardening – Features –Plants suitable – Planning – Maintenance.
8. Vertical gardening – Components.
9. Garden components or features-Garden walls – Retaining wall – Fences and Gates – Hedges and Edges – Flower bed – Borders – Carpet Bedding - Steps – Garden Drives (Gravel and Asphalt) and Paths (Gravel, Brick, Grass, Stone, Crazy pavings).
10. Arches and Pergolas – Screens – Bridges – Outdoor garden rooms (Gazebos, garden pavilions, band stand, bower and thatched huts) walk-Paths, bridges, other constructed features etc.
11. Garden adornments– Garden Seats – Ornamental tubs, urns and vases – Bird baths – Sun dials – Floral Clocks – Japanese Lanterns – Ornamental Stones – Fountains – Statues – Towers – Wells – Plants Containers – Plant Strands.
12. Lawn making– Selection of Grass – Bermuda grass – Korean grass – Poa grass – Fescue grass – 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.
13. Turfing – Turf plastering – Bricking – Planting on Polythene – Maintenance of lawn – Mowing – Rolling – Sweeping – Scraping – Raking – Weeding – Irrigation – Top dressing with compost and fertilizers - Diseases and other problems – Fairy ring – Pale Yellow Lawns.
14. Rockery- Rock Garden – Types of rock garden – Selection of site – Construction of the Rockery – Planting – Management of the Rockery – Plants for rock garden – Examples of cacti and succulents, ferns, shrubs, herbaceous plants, bulbs, flowering annuals.
15. Water garden – Informal pool – 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 – Marginals.
16. Gardens for special purposes- Specialized gardens – Herb garden – Bog Garden – Sunken garden – Topiary Garden – Kitchen garden – Paved garden – Moon Garden – Gardening in hanging baskets – Window garden – Miniature garden – Mini Zoo – Importance of Green house – Conservatory – Lath house – Fernery in ornamental horticulture.
17. Trees: Selection, propagation, planting schemes, canopy management-Ornamental and shady Trees – Definition – Classification based on purpose with

suitable examples – Specimen trees – Shady trees – Flowering trees – Avenue or road side trees – Screening trees – Fragrant flowering trees – Pollution controlling trees – Selection of trees based on – Climatic – Soil – availability and Cost factors- Methods of planting – Time of planting – Manuring – Care and Maintenance – Planting Schemes for avenue planting – One kind of flowering tree on both sides – Two kinds of lowering trees blooming at one time on both sides of road – Two kinds of flowering trees blooming at different times on both sides of road – Shady trees only on both sides of road.

18. Shrubs - Definition – Utility (aesthetic values) – Classification with suitable examples – Based on purpose of growing – Flowering – Foliage – Flowering and foliage – Fragrant shrubs – Based on sunlight requirement – Shrubs requiring full sunlight – Semi shade – intermediate group (semi shade and sun) – Planting of Shrubs in garden – Specimen shrub – Standard shrub – Shrubbery border – Arrangement of shrubs – According to height and colour – Growing of shrubs – Soil – Climate – Preparation of soil – Planting – Propagation – Seeds – Cuttings - Layering – After care – Irrigation – Weeding – Pruning.
19. Herbaceous perennials – Definition – Introduction – Classification with suitable examples – Herbaceous perennials for plains and for hills – Planting – Manuring Propagation.
20. Climber and creepers: Utility (aesthetic values) – Classification with suitable examples – Sunny situation – Partial shade – Shade loving climbers – Showy flowering climbers – Climbers with scented flowers – Climbers with attractive foliage – Climbers for pots – Annual climbers – Climbers for hedge making – Classification based on vegetative growth – Heavy climbers – Light climbers – Soil – Digging of pits – Planting of climbers – After care – Manuring - Maintenance. Annuals: classification- Summer annuals- Winter annuals- Flowering annuals- Foliage annuals- Propagation - Colour scheme- Grouping – After care – Maintenance
21. Palms- – Definition – Introduction – Utility (aesthetic values) – Classification with examples – Feather leaved Palm – Fan leaved Palm – Propagation – Pot culture – Potting – Re-potting - Potting media – Manuring – After care.
22. Ferns- – Introduction – Utility (aesthetic values) – Propagation – Spore – Division of Clumps –Suckers – Bulbils – Site of growing – Soil media – Pot culture – Repotting– Irrigation - Indoor culture – Important Examples. Selaginellas – Introduction – Propagation – Cultural hints – Important Examples.
23. Ornamental grasses- Bamboos and reeds – Introduction – Propagation – Soil and climatic requirements – Site of growing – Planting – Important Examples.
24. Cacti – Introduction – Characteristics of Cactaceae – Site of growing – Natural habitat –Domestication (Housing of cacti) – Propagation – Seeds – Offsets – Grafting – Soil – Climate – Containers – Time and method of planting – Potting – Re-potting – Irrigation – Staking.

25. Succulents – Characteristics – Difference between cacti and succulents – Utility (aesthetic values) – Climate – Soil – Housing – Propagation – Seeds – Cuttings – Watering – Re-potting – Summer protection.
  26. Pot plants: introduction – Pots – Potting – Potting- Compost – Re-potting - Arrangement, management.
  27. Bio-aesthetic Planning – Definition – Aim and Concept – Need for Bio-aesthetic planning – Air pollution – Human welfare.
  28. Landscaping of urban and rural areas, Peri-urban landscaping- Road side -Planting trees in colonies– Landscaping City parks – Large –Medium –Small parks – Pleasure grounds – Examples of ornamental shade and flowering trees for town roads.
  29. Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions. Importance – Need – Planting materials for different areas of institutions.
  30. Bonsai: Definition – Criteria for selecting plants – Examples – Classification of Bonsai – Upright (formal and informal) – Production management - Production, plant layout and material handling - Winding – Oblique – Gnarled– Semi-cascade-cascade – Clasped to stone – Containers (pots) and Media – Potting and Re-potting – Training – Pruning and Pinching (Shoot, leaf and root) – Watering– manuring – Defoliation – Mame Bonsai.
- 31&32. Computer Aided Designs (CAD) – Applications in landscaping.

### **Practical**

1. Identification of avenue trees.
2. Identification of shrubs.
3. Identification of annuals.
4. Identification of pot plants.
5. Propagation of ornamental trees.
6. Propagation of shrubs.
7. Propagation of annuals, care and maintenance of plants.
8. Potting and repotting of ornamentals.
9. Identification of tools and implements used in landscape design.
10. Training and pruning of plants for special effects.
11. Lawn establishment and maintenance.
12. Study of planning, designing and 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.
16. Visit to important gardens/ parks/ institutes.

## References

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2. Bose, T.K. 1999. *Floriculture and Landscaping*. Naya Prakash, Kolkatta.
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**ELCT 383**

**PROTECTED CULTIVATION**

**3 (2+1)**

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

#### Practical

Raising of seedlings and saplings under protected conditions, use of 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 ad misting.

### Lecture outlines

#### Theory

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. Green houses – Definition- History - Green house effect – Advantages of green houses.

4. Types of green houses – Types of green houses based on shape, utility, construction and cladding material.
5. Greenhouse design – Locating a green house, green house orientation – Layout of green house – Material requirement – Erection.
6. Cladding material involved in greenhouse/ poly house – Glass, flexible plastic films, polyethelene, Ethylene Venyl acetate, poly venyl fluoride, poly venyl chloride, acrylic, tefzel T<sup>2</sup> film, reinforced plastic, rigid plastic sheet, Saran plastic mesh.
7. Environment control - Light - Supplemental lighting – Incandescent lamp, florescent lamp, high intensity discharge lamps - Temperature control - Heat distribution.
8. Environment control - Ventilation and cooling in a green house – Naturally ventilated, Fan and Pad cooling, forced air cooling etc. – Relative humidity, carbon-di-oxide level.
9. Soil preparation and management – Soil sterilization methods – Soil and soilless media (cocopeat, vermicompost, perlite, vermiculite, charcoal, pumice, rockwool etc.,) - Substrate management.
10. Types of benches and containers – No bench, raised benches, ground benches – Arrangement of benches – Longitudinal, cross-benching, peninsula arrangement, movable benches, pyramid benches – Containers – Types of containers.
11. Irrigation management - Water application methods – Hand watering and automatic watering systems- Tube watering, capillary mat, overhead sprinklers, perimeter watering, drip system, misting – Fertigation – Dry and liquid fertilizers – Methods of application of liquid fertilizers (constant feed and intermittent feed) –Carbon-di-oxide fertilization.
12. Automation – Parameters to be controlled – Types of green house control – Step control, integrated control, feedback, proportional, integral, derivative, feed forward, energy balance, sensors (Temperature, Light, CO<sub>2</sub>, Humidity, Irrigation etc.).
13. Propagation and production of quality planting material of horticultural crops – Asexual and sexual methods of proppagation.
14. Greenhouse cultivation of important horticultural crops – Rose – Introduction – varieties suitable for green house cultivation – Climatic requirements - Planting – Spacing, planting density.
15. 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.
16. Carnation - Introduction – Varieties suitable for green house cultivation – Climatic requirements – Planting – Spacing, planting density - Fertilizer requirement – fertigation – Training, pruning – Special intercultural operations (Netting, Pinching) – Use of growth regulators - Harvesting – Grading & packing – yield.

17. Chrysanthemum - Introduction – Varieties suitable for green house cultivation – Climatic requirements – Planting – Spacing, planting density.
18. Chrysanthemum - Fertilizer requirement – Fertigation – Training, pruning – Special intercultural operations (pinching, disbudding, staking, de-suckering) – Use of growth regulators - Harvesting – Grading & packing – yield.
19. Gerbera - Introduction – Varieties suitable for green house cultivation – Climatic requirements – Planting – Spacing, planting density - Fertilizer requirement – Fertigation – Special intercultural operations (Defoliation, soil loosening, shading) – Use of growth regulators - Harvesting – Grading & packing – Yield.
20. Orchids - Varieties for green houses production – Climatic and substrate requirement – Propagation – Planting – Fertilizer requirement- Use of growth regulators – Physiological disorders – Harvesting – Grading and packing – Yield.
21. Anthurium - Varieties suitable for green house cultivation – Climatic requirements – Growing media - Planting – Spacing, planting density - Fertilizer requirement – Fertigation – Special intercultural operations (Defoliation, de-suckering) – Use of growth regulators - Physiological disorders- Harvesting – Grading & packing – Yield.
22. Lilium - Varieties suitable for green house cultivation – Climatic requirements – Growing media - Planting – Spacing, planting density - Fertilizer requirement – Special intercultural operations (Defoliation, de-suckering) – Use of growth regulators - Physiological disorders- Harvesting – Grading & packing – Yield.
23. Tulip - Varieties suitable for green house cultivation – Climatic requirements – Growing media - Planting – Spacing, planting density - Fertilizer requirement – Special intercultural operations (Defoliation, de-suckering) – Use of growth regulators - Physiological disorders- Harvesting – Grading & packing – Yield.
24. Tomato - Varieties suitable for green house cultivation – Climatic requirements – Soil preparation - Planting – Spacing, planting density – Training and pruning - Fertilizer requirement –Intercultural operations – Harvesting – Yield.
25. Bell pepper - Varieties suitable for green house cultivation – Climatic requirements – Soil preparation - Planting – Spacing, planting density – Training and pruning -Fertilizer requirement –Intercultural operations – Harvesting – Yield.
26. Cucumber - Varieties suitable for green house cultivation – Climatic requirements – Soil preparation - Planting – Spacing, planting density – Training and pruning - Fertilizer requirement –Intercultural operations – Harvesting – Yield.
27. Strawberry - Varieties suitable for green house cultivation – Climatic requirements – Soil preparation - Planting – Spacing, planting density – Training and pruning - Fertilizer requirement –Intercultural operations – Harvesting – Yield.
28. Pot plants – Selection of plants – Climatic requirement – Potting and Repotting – Management of pot plants.
29. Cultivation of economically important medicinal – Stevia, Ginseng and aromatic plants.

30. Off-season production of flowers and vegetables – Flower forcing – Techniques – Vegetable forcing – Techniques.
31. 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 Green house.
32. 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 – Nematodes and their management.

### **Practical**

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

### **References**

1. Vilas M. Salone and Ajay K. Sharma.2012. *Greenhouse Technology and Applications*. Agrotech Publishers. New Delhi.
2. S. Prasad and U. Kumar. 2012. *Greenhouse Management of Horticultural Crops*. Second edition, Agrobios. New Delhi
3. Joe.J.Hanan. 1998. *Green houses: Advanced Technology for Protected Horticulture*, CRC Press, LLC. Florida.
4. K.Radha Manohar and C. Igathinathane, 2013. *Greenhouse Technology and Management* BS Publications.
5. Paul V. Nelson. 1991. *Green House Operation and Management*. Ball publishing USA.

### **Student Rural Entrepreneurship Awareness Development Yojana (READY)**

The student READY (Rural Entrepreneurship Awareness Development Yojana) Programme aims to provide rural entrepreneurship awareness, practical experience in real-life situation in rural agriculture and creating awareness to undergraduate student about practical agriculture.

### **Rural Awareness Works Experience (RAWE) and Agro-Industrial Attachment (AIA)**

The programme will be undertaken by the students during the VII semester for a total duration of 20 weeks with a weightage of 0+20 credit hours in two parts viz., RAWE and AIA. It will consist of general orientation and on campus training by different faculties followed by village attachment/unit attachment in University/College/KVK or a Research station. The students will be attached with the agro-industries to get an experience of the industrial environment and working. Weightage in terms of credit hours will be given depending upon the duration of stay of students in villages/agro-industries. At the end of RAWE/AIA, the students will be given one week for project report preparation, presentation and evaluation. The students would be required to record their observations in field and agro-industries on daily basis and will prepare their project report based on these observations.

### **Experiential Learning Programme (ELP)**

This programme will be undertaken by the students preferably during the VIII semester for a total duration of 24 weeks with a weightage of 0+20 credit hours. The students will register for any of two modules (of 0+10 credit hours each) listed below :

1. Production Technology for Bio-agents and Bio-fertilizers
2. Seed Production and Technology
3. Mushroom Cultivation Technology
4. Soil, Plant, Water and Seed Testing
5. Poultry Production Technology
6. Hybrid Seed Production Technologies
7. Floriculture and Landscaping
8. Food Processing
9. Commercial Horticulture
10. Agriculture Waste Management
11. Organic Production Technology
12. Commercial Sericulture



**Meeting on Revision of the  
Under Graduate (B.Sc. (Hons) Agriculture) Syllabus held at  
Agricultural College, Bapatla on 5.10.2016**



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