Course Curricula for Undergraduate programme

Agriculture UG- Certificate in Agriculture/

UG-Diploma in Agriculture/

B.Sc. (Hons) Agriculture

[As per 6th Deans Committee Recommendations]

BIDHAN CHANDRA KRISHI VISWAVIDYALAYA

Faculty of Agriculture

P.O: KrishiVIswavidyalaya, Dist. Nadia-741252, West Bengal, India

A. Summary of Credit Distributions

Type of courses		Credits
Core courses including Elective Course (EC)	:	114
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses(SEC)	:	12
Internship/Student READY	:	20
**MOOCS/SWAYAM (non-gradial)	:	10
Total	:	**169+10****

B. Semester wise distribution of courses

S. No	Course Title	Depts. offering the course	Credit Hours	Total credit hours
	First year			
	Semester I			
1	**CC 101:** *Deeksharambh* (Induction cum Foundation course)	Deans/Secretaries of three Faculties	1week (NG) Non-gradial	**21 (11+10)**
2	**CC 102:** Communication Skills	Dean+AEX	2(1+1)	
3	**CC 103:** Environmental Studies and Disaster Management	ACSS+ AMP	3(2+1)	
4	**CC 104:** National Service Scheme-I (NSS-I)	NSS	1(0+1)	
5	**AGR 105:** Fundamentals of Agronomy	AGR	3(2+1)	
6	**ACSS 106:** Fundamentals of Soil Science	ACSS	3(2+1)	
7	**AEX 107:** Rural Sociology and Educational Psychology	AEX	2(2+0)	
8	**Hort (A) 108:** Fundamentals of Horticulture	F./ Hort	3(2+1)	
9	**SEC (I) 109:** Skill Enhancement course-I: **Vermicompost Production**	AGR	2(0+2)	
10	**SEC (I) 110:** Skill Enhancement course-I **Production of Ornamental fish & Aquarium plants (ASC)**	ASC	2(0+2)	
11	**SEC (II) 111:** Skill Enhancement course-II: **Mushroom Production**	PPA	2(0+2)	
12	**SEC (II) 112:** Skill Enhancement course-II: **Seed Production Technology of Vegetable crops**	F./ Hort	2(0+2)	
13	**AST 113:** Introductory mathematics (**Non-gradial)**	AST	1(1+0)	
	Semester II			
1	**CC 151:** Farming based livelihood systems	AGR, ASC, Hort, AEX, AEC	3(2+1)	**21(10+11)**
2	**CC 152:** Personality Development	AEX	2(1+1)	
3	**CC 153:** National Service Scheme-II (NSS-II)	NSS	1(0+1)	
4	**ACSS 154:** Soil Fertility Management	ACSS	3(2+1)	
5	**AEN 155:** Fundamentals of Entomology	AEN	3(2+1)	
6	**PPA 156:** Fundamentals of Plant Pathology	PPA	3(2+1)	
7	**ASC 157:** Livestock and Poultry Management	ASC	2(1+1)	
8	**SEC (III) 161:** Skill Enhancement course-III**:** **Soil, water and plant testing**	ACSS	2(0+2)	

9	**SEC (III) 162:** Skill Enhancement course-III**: Commercial Apiculture**	AEN	2(0+2)	
10	**SEC (III) 163:** Skill Enhancement course-III**: Orchard floor management**	F./ Hort	2(0+2)	
11	**SEC (IV) 164:** Skill Enhancement course-IV: **Agro forestrymanagement**	SWC	2(0+2)	
12	**SEC (IV) 165:** Skill Enhancement course-IV: **Organic production Technology**	AGR	2(0+2)	
13	**SEC (IV) 166:** Skill Enhancement course-IV: **Nursery production of horticultural crops**	F./ Hort	2(0+2)	
	Second year			
	Semester III			
1	**CC 201:** Physical Education, First Aid, Yoga Practices and Meditation	Deans, all Faculties	2(0+2)	**22 (10+12)**
2	**AGR 202:** Crop Production Technology-I (*Kharif* crops)	AGR	3(1+2)	
3	**AGR 203:** Principles and Practices of Natural Farming	AGR	2(1+1)	
4	**GPB 204**: Principles of Genetics	GPB	3(2+1)	
5	**AEN 205**: Fundamentals of Nematology	AEN	2(1+1)	
6	**AEX 206**: Fundamentals of Extension Education	AEX	2(1+1)	
7	**AEC 207:** Principles of Agricultural Economics and Farm Management	AEC	2(2+0)	
8	**Hort (A) 208:** Production Technology of Fruit and Plantation Crops	F./ Hort	2(1+1)	
9	**AEG 209:** Farm Machinery and Power	F. / Agril. Engg	2(1+1)	
10	**SEC (V) 211:** Skill Enhancement course-V **Production Technology of Bioagents**	AEN	2(0+2)	
11	**SEC (V) 212:** Skill Enhancement course-V **Production of Botanical Pesticides**	ACH	2(0+2)	
12	**SEC (V) 213:** Skill Enhancement course-V **Post Harvest Management of Horticultural crops**	F./ Hort	2(0+2)	
13	**SEC (V) 214:** Skill Enhancement course-V **Seed production and Processing Technology**	SST	2(0+2)	
14	**SEC (V) 215:** Skill Enhancement course-V: **Molecular Data Analytics**	ABT	2 (0+2)	
	Semester IV			
1	**CC 251:** Agricultural Informatics and Artificial Intelligence	AST	3(2+1)	**22(11+11)**
2	**CC 252:** Entrepreneurship Development and Business Communication	AEC	3(2+1)	
3	**AGR 253:** Crop Production Technology-II (Rabi Crops)	AGR	3(1+2)	
4	**AGR 254:** Water Management	AGR	2(1+1)	
5	**ACSS 255:** Problematic Soils and their management	ACSS	2(1+1)	
6	**GPB 256:** Basics of Plant Breeding	GPB	3(2+1)	
7	**ACH 257:** Basic concept on Pesticides	ACH	2(1+1)	
8	**Hort (A) 258**: Production Technology of Vegetables and Spices	F./ Hort	2(1+1)	
10	**SEC (VI) 261:** Skill Enhancement course-VI: **Micropropagation technologies**	GPB	2(0+2)	

11	**SEC (VI) 262:** Skill Enhancement course-VI: **Landscape gardening**	F./ Hort	2(0+2)	
12	**SEC (VI) 263:** Skill Enhancement course-VI: **Biofertlizer Production Technology**	ACSS +AGR	2(0+2)	
13	**SEC (VI) 264:** Skill Enhancement course-VI: **Production of Microbial Biocontrol agents**	PPA	2(0+2)	
	Third year			
	Semester V			
1	**CC 301:** Agricultural Marketing and Trade	AEC	3(2+1)	
2	**AGR 302:** Weed Management	AGR	2(1+1)	
3	**AEN 303:** Pest management in Crops and Stored Grains	AEN	3(2+1)	
4	**PPA 304:** Diseases of Field & Horticultural Crops & their Management	PPA	3(2+1)	
5	**GPB 305**: Crop Improvement (Rabi crops)- II	GPB	2(1+1)	
6	**ACSS 306**: Agricultural Microbiology and Phyto-remediation	ACSS & PPA	2(1+1)	**22(13+9)**
7	**ABC 307**: Essentials of Plant Biochemistry	ABC	3(2+1)	
8	**SWC 308:** Introductory Agroforestry	SWC	2(1+1)	
9	**Hort (A) 309:** Ornamental Crops, MAPs and Landscaping	F./ Hort	2(1+1)	
10	**AG 310:** Study tour (Non Gradial)	Dean, F./Ag.	2(0+2)	
	Semester VI			
1	**AGR 351:** Dry land agriculture/Rainfed agriculture and watershed management	AGR	2(1+1)	
2	**AMP 352:** Introduction to Agro-meteorology	AMP	2(1+1)	
3	**GPB 353:** Crop Improvement (kharif crops)-I	GPB	2(1+1)	
4	**ABT 354:** Fundamentals of Agri-Biotechnology	ABT	3(2+1)	
5	**AST 355:** Basic and Applied Agril Statistics	AST	3(2+1)	**21(12+9)**
6	**PPH 356:** Fundamentals of Crop Physiology	PPH	3(2+1)	
7	**AEC 357:** Agricultural Finance & Cooperation	AEC	2(1+1)	
8	**SST 358:** Fundamentals of Seed Science &Technology	SST	2(1+1)	
9	**AEG 359:** Renewable energy in Agriculture and Allied Sector	AEG	2(1+1)	
	Fourth year			
	Semester VII*			
1	5 Elective Courses (major/ minor) each of 4 (3+1) credits for B.Sc. (Hons) Agriculture degree	**Table 4**	4 (3+1)	**20 (15+5)**
	Semester VIII			
1	For B.Sc.(Hons) Agriculture Degree Student READY :RAWE/ Industrial Attachment /Experiential Learning / Hands-on Training/ Project Work / Internship	Dean, F./ Ag	0+20	**20 Credits**
			Total	**169**
	***Online courses**		10	**10**
			Grand Total	**169+10***

Bouquet of EC Courses to be offered in 7th Semesters

Sl. No.	Course No.	Title of Course	Credit(s)	Offering Department
1	EC 401	Hill, Dry land and Coastal Agriculture: Scenario in West Bengal	4(3+1)	AGR
2	EC402	Principles and Practices of Organic Farming and Conservation Agriculture	4(3+1)	AGR
3	EC403	Issues and Advances in Weed Management	4 (3+1)	AGR
4	EC 404	Watershed and Wetland Management	4(3+1)	SWC+AGR+ASC
5	EC 405	Production and Use of Biofertilizers	4(3+1)	ACSS
6	EC 406	Agriculture Waste Management	4(3+1)	ACSS
7	EC 407	Deficiency and Toxicity of Elements in Soil, Plant, Water	4 (3+1)	ACSS
8	EC 408	Non-insect Pests of Crops and Their Managements	4 (3+1)	AEN
9	EC 409	Bio-control Agents and Bio-pesticides in insect-pest Management	4 (3+1)	AEN
10	EC 410	Insect Ecology & IPM	4 (3+1)	AEN
11	EC 411	Commercial Entomology	4 (3+1)	AEN
12	EC 412	Principles and methods of plant disease management	4 (3+1)	PPA
13	EC 413	Essentials of Plant Pathology	4 (3+1)	PPA
14	EC 414	Commercial Plant Breeding	4 (3+1)	GPB
15	EC 415	Weather Services, Crop weather modeling & Climate change in Agriculture	4(3+1)	AMP
16	EC 416	Agricultural Journalism	4 (3+1)	AEX
17	EC 417	Strategies and approaches of Agricultural Extension	4 (3+1)	AEX
18	EC 418	Agricultural Business Management	4 (3+1)	AEC
19	EC 419	Agricultural Development Policy Analysis	4 (3+1)	AEC
20	EC 420	Statistical Methods I	4 (3+1)	AST
21	EC 421	Statistical Methods II	4 (3+1)	AST
22	EC 422	Biotechnology for Crop Improvement	4 (3+1)	ABT
23	EC 423	Plant Bio-chemistry and Molecular Biology	4 (3+1)	ABC
24	EC 424	Plant Developmental Biology	4 (3+1)	PPH
25	EC 425	Advances in Seed Technology	4 (3+1)	SST+AGR
26	EC 426	Pesticides Chemistry and Technology	4 (3+1)	ACH
27	EC 427	Soil and Water Conservation	4 (3+1)	SWC

SEMESTER 1

CC 101: *Deeksharambh* (Induction-cum-Foundation Course)-Non gradial 1 (1+0)

Objectives

- Help for cultural integration of students from different backgrounds,
- Know about the operational framework of academic process in the University/College/Institute
  Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both inindigenous and developed scenario.
- Identify strength and weakness of the students in different core areas of the discipline.
- The details of activities will be decided by the parent universities. The structure shall include,but not restricted to:
- Discussions on operational framework of academic process in the University, as well asinteractions with academic and research managers of the University
- Interaction with alumni, business leaders, perspective employers, outstanding achievers inrelated fields, and people with inspiring life experiences
- Group activities to identify the strength and weakness of students (with expert advice fortheir improvement) as well as to create a platform for students to learn from each other's lifeexperiences
- Activities to enhance cultural Integration of students from different backgrounds.
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethicsand values, team work, leadership, etc.) and communication skills

CC 102: Communication Skills 2 (1+1)

Objective

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

Theory

Communication Process: Communication; concept, definition, importance; elements of communication process, Building self-esteem, self efficacy & self monitoring, Models of communication and types of communication; Verbal and non-verbal communication; barriers to communication and reasons behind communication gap/ Miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Summarizing; Style of technical communication, Curriculum vitae/resume writing;Innovative methods to enhance vocabulary.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words andverbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: Tense, voice change; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: Precis writing, Summarizing; Reading and comprehension (written and oral) of general and technical articles; Impromptu Presentations: Stage manners: grooming, body language; Group discussions; Public speaking exercises; Interview Techniques.

Suggested Readings

- Mondal Sagar 2018. Communication Skills and Personality Development, Kalyani Publishers, Ludhiana
- Acharya, S.K. and Adhikary, M.M. (2012) Communication: The Process and Application in Extension Education. Agrotech Publishing House , Udaipur.
- Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
- Francis Peter, S. J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New
- Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford UniversityDelhi.
- Kumar, S. and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
- Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
- Raman, M. and Singh, P. 2000. Business Communication. Oxford University Press.
- Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.

CC 103: Environmental Studies and Disaster Management 3 (2+1)

Objective

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

Theory

Introduction to Environment: Environmental studies: Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth- Lithosphere - Hydrosphere – Atmosphere - Different layers of atmosphere.
Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems: Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem.
Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.
Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution h.Light pollution.
Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis Biogas production, Causes, effects and control measures of urban and industrial wastes.
Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management.
Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservatio Act.
Human Population and the Environment: Environment and human health:Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.
Disaster management: Disaster definition - Types - Natural Disasters - Floods, drought,cyclone, earthquakes, landslides avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National

strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversit assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

- De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers,New Delhi ISBN:13–978 81 224 2617 5. 384 pp
- Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36pp.
- Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
- Parthiban, K.T. Vennila, Prasanthrajan, S., Umesh, M. and Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India. (In Press).
- Prasanthrajan M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition:2008
- Prasanthrajan M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
- Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India
- Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections,and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

CC 104: National Service Scheme (NSS-1) 1 (0+1)

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

Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community based organizations) and society.

AGR 105: Fundamentals of Agronomy 3 (2 +1)

Objectives

- To impart the basic and fundamental knowledge of Agronomy.

Theory

Agronomy and its scope: Definition, Meaning and scope of Agronomy; Art, science and business of crop production, relation of Agronomy with other disciplines of Agricultural Science, Fields crops and classification, importance, ecology and ecosystem, Seeds and sowing: Definitions of crops, variety and seed. Factors affecting crop stands establishment: good quality seed, proper tillage, time of sowing seed rate, depth and method of sowing: broadcasting, drilling, dibbling, transplanting etc. Tillage and tilth: Definition, objectives, types, advantages and disadvantages of tillage including conservation tillage. Crop density and geometry: plant geometry and planting geometry, its effect on growth, yield. Sustainable crop production: Definition, importance and practices, natural resources and conservation pollution and pollutants,

Crop nutrition: Definition of essential nutrients, criteria of essentiality, functional elements, classification of essential nutrients, role of macro and micro nutrients. Nutrient absorption, active and passive absorption of nutrients, forms of plant nutrients absorbed by plants, Combined /un-combined forms
Manures and fertilizers, nutrient use efficiency: Sources of nutrients: Inorganic (fertilizers), organic (manures) and bio-fertilizers; their classification and characteristics, method of preparation and role of organic manures in crop production.

Integrated Nutrient Management: Meaning, different approaches and advantages of INM, Green manure- role in crop production: Definition, objectives types of green manuring, desirable characteristics, advantages and limitations of green manuring ,

Cropping systems: Factors affecting cropping systems, major cropping patterns and systems in the country.

Water management: Water resources of the world, India and the state; Soil Moisture Constants – gravitational water, capillary water, hygroscopic water, Soil moisture constants, Concept of water availability to plants, soil-plant-water relationship, crop water requirement, water use efficiency, Methods of irrigation : Scheduling of irrigation, different approaches of scheduling irrigation

Weeds: Definition, Importance and basics of classification of weeds and their control Allelopathy: Meaning and importance in crop production

Growth and development of crops: Definition, Meaning and factors affecting growth and development

Practical

A visit to Instructional Crop farm and study on field crops, Identification of crops, seeds, fertilizers, pesticides, Crops and cropping systems in different Agro-climatic zones of the state, Study of some preparatory tillage implements, Study of inter tillage implements, Practice of ploughing / puddling, Study and practice of inter cultivation in field crops, Numerical exercises on calculation of seed, plant population and fertilizer requirement, Study of yield contributing characters and yield estimation of crops, Identification of weeds in different crops, Seed germination and viability test of seed, Practice on time and method of application of manures and fertilizers, Measurement of soil moisture by gravimetric and volumetric method and bulk density, Determination of field capacity, Determination of gross and net irrigation requirement, Determination of infiltration rate

Suggested readings

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

ACSS 106: Fundamentals of Soil Science 3 (2+1)

Objective

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

Theory

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

Practical

Study of general properties of minerals, study of minerals-silicate and non-silicate minerals, study of rocks-igneous, sedimentary and metamorphic rocks; study of a soil profile, collection and processing of soil for analysis, study of soil texture-feel method, mechanical analysis determination particle density and soil porosity, determination of soil colour, study of soil structure and aggregate analysis, determination of soil moisture, determination of soil moisture content, field capacity; water holding capacity. Study of infiltration rate of soil, determination of pH andElectrical conductivity of soil.

Suggested readings

- Introductory Soil Science – by Dilip Kumar Das, Kalyani Publishers
- Textbook of Soil Science – by S. K Pal. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
- Soil Fertility and Nutrient Management – by S. S. Singh, Kalyani Publishers
- Soil Fertility and Fertilizers – by Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York
- The Nature and Properties of Soils – by Harry O. Buckman and Nyle C.

AEX 107: Rural Sociology and Educational Psychology 2 (2+0)

Objective

- Provide knowledge on concept and importance of sociology and rural sociology as well asthe relationship with Extension Education

Theory

Extension Education and Agricultural Extension: Meaning, definition, scope, and importance. **Sociology and rural sociology:** Meaning, definition, scope, importance of rural sociology in Agricultural Extension, an interrelationship between rural sociology and Agricultural Extension. **Indian Rural Society:** Important characteristics, differences and relationship between rural and urban societies. **Social Groups:** Meaning, definition, classification, factors considered in formation and organization of groups, motivation in group formation and role of social groups in Agricultural Extension. **Social Stratification**: Meaning, definition, functions, basis for stratification, forms of social stratification- characteristics and- differences between class and caste system. **Cultural concepts:** Culture, customs, folkways, mores, taboos, rituals. **Traditions:** Meaning, definition and their role in Agricultural Extension. **Social Institutions:** Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension. **Social change:** Meaning, definition, nature of social change, and factors of social change. **Leadership:** Meaning, definition, classification, roles of leader, different methods of selection of professional and lay leaders, **Psychology and Educational Psychology:** Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. **Teaching and Learning process:** Meaning and definition of teaching, learning, learning experience and learning situation, elements of learning situation and its characteristics. Principles of learning and their implication of teaching.

Suggested Readings

- Mondal Sagar 2017. Textbook of Rural Sociology and Educational Psychology
- J.B. Chitambar -Introductory Rural Sociology
- Tiwari, G., Somani, L.L., Acharya, S.K. (2015). Agricultural and Rural Sociology: Strategic Foundation for Rural Transformation. Agrotech Publishing House, Udaipur.
- R. Desai -Rural Sociology in India
- Ray, G. L. -Extension Communication and Management

HORT (A) 108: Fundamentals of Horticulture 3 (2+1)

Objectives

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

Theory

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

Practical

Identification and nomenclature of fruit, Layout of an orchard, pit making and system of planting, Nursery raising techniques of fruit crops, Understanding of plant propagation

structures, Propagation through seeds and plant parts, Propagation techniques for horticultural crops, Container, potting mixture, potting and repotting, Training and pruning methods on fruit crops, Preparation of fertilizer mixture and application, Preparation and application of PGR, Layout of different irrigation systems, Maturity studies, harvesting, grading, packaging and storage.

Suggested readings

- Basics of Horticulture by Jitendra Singh
- Introduction to Horticulture by N. Kumar
- Handbook of Horticulture by ICAR

SEC (I) 109: Skill Enhancement course-I: Vermicompost Production 2(0+2)

Introduction of vermiculture, Waste materials: Classification, disposal techniques, their segregation and processing, Bed preparation for anaerobic and aerobic composting and mixing of beds ,Earthworm collection, identification and application on beds, vermicompost collection, earthworm separation, Air drying of vermicomposting, sieving and storing, vermi-wash production technique, collection and processing, Study of vermi disease and enemies and their control, Nutritional composition of vermicompost for plants. technique of composting in a limited space, scope of vermicomposting as entrepreneurship.

SEC (I) 110: Production of Ornamental fish & Aquarium plants 2(0+2)

Practical

Morphological and Anatomical Study of Ornamental Fish Species: (i) Identification of different types of ornamental fishes with special reference to morphological features. (ii) Anatomy of different types of ornamental fishes with special reference to breeding habits and behaviour.
Breeding and Rearing of Ornamental Fishes: (i) Demonstration of the setting up of infrastructures, facilities and methods for breeding of different types of ornamental fishes. (ii) Demonstration of rearing methods and management of different types of ornamental fish seed.
Fabrication, Setting up and Management of Freshwater Aquarium: **(i)** Demonstration of the fabrication of aquariums. (ii) Demonstration of setting up and decoration of different types of aquaria, (iii) Management of different types of functional aquaria.
Mass Culture of Live Food Organisms for Ornamental Fish Rearing: (i) Identification of different types of live-food organisms. (ii) Culture and production of different types of live food organisms.
Propagation of Aquarium Plants: (i) Identification of different types of aquarium plants.(ii) Propagation of different types of aquarium plants.
Live Fish Transportation: (i) Demonstration of different methods for transportation of live fish.

SEC (II) 111: Skill Enhancement course-II: Mushroom Production 2(0+2)

Practical
Scope and importance of mushroom cultivation. Morphology and types of mushrooms. Isolation, purification and transfer of mushroom fungus on new culture medium for sub-culturing. Facilities required for spawn production. Techniques of spawn production. Structure of a commercial mushroom growing unit. Cultivation methods and economics of mushrooms cultivation. Post- harvest handling, and marketing of mushrooms. Diseases and pests of mushrooms and their management.

SEC (II) 112: Skill Enhancement course-II: Seed Production Technology of Vegetable crops 2(0+2)

Vegetable seed industry in India, Floral biology, pollination and breeding behaviour of important vegetable crops, Categories of seeds and their maintenance, Characteristics of quality seed, Agronomical principles and methods of seed production in important vegetable crops, Use of growth regulators and chemicals in vegetable seed production, Methods of hybrid seed production, Seed harvesting, extraction, curing, drying, grading, packaging and storage, Seed sampling and seedtesting (genetic purity, seed viability, seedling vigour, germination, physical purity), Visit to seedprocessing units, seed testing laboratory and seed production farms.

AST 113: Introductory Mathematics (Non-gradial) 1 (1+0)

Theory

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

SEMESTER II

CC 151: Farming based livelihood systems 3 (2+1)

Objectives

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

Theory

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

Practical

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

Suggested Readings

- Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7.
- Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally,Sound and Participatory Rural Development, Center for Science and Environment, New Delhi,India.
- Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – RegionalAnalysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.
- Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: ImprovingFarmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington,DC, USA.
- Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. InFAO, The State of Food and Agriculture, FAO, Rome, Italy.
- Livelihood Improvement of Underprivileged Farming Community: Some Experiences fromVaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, AmitavaDeyUjjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N.Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex forEastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar.
- Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
- Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
- Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-IndianInstitute of Farming Systems Research, Modipuram.
- Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, ScientificPublishers, Jodhpur, Rajasthan.

CC 152: Personality Development 2 (1+1)

Objective

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

Theory

Personality Definition, Nature of personality, theories of personality and its types. Determinants of personality, Tips to improve personality, Locus of control and performance, Type A and Type B behaviours. Foundations of individual behavior and factors influencing individual behavior, Perception and attributes and factors affecting perception, Attributiontheory. Learning: Meaning and definition, theories and principles of learning, Learning and training. Attitude and values. Intelligence-concept, definition types of Intelligence, theories of intelligence, measurements of

intelligence, factors influencing intelligence, emotional intelligence. Motivation- concepts, socio psychological needs; theories of motivation Teamwork and group dynamics.

Practical

MBTI personality analysis, Motivational needs, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles.

Suggested Readings

- Mondal Sagar 2017. Textbook of Rural Sociology and Educational Psychology.
- Mondal Sagar 2018. Communication Skills and Personality Development, Kalyani Publishers, Ludhiana.
- Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House
- Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
- Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.

CC 153: National Service Scheme (NSS-II) 1(0+1)

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

ACSS 154: Soil Fertility Management 3 (2+1)

Objective

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

Theory

History of soil fertility and plant nutrition. Criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of macro and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Introduction and importance of manures and fertilizers. Fertilizer recommendation approaches.

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

Practical

Introduction of analytical instruments and their principles, calibration and applications of Coloremetry and flame photometry; Estimation of alkaline hydrolysable N in soils; Estimation of soil extractable P in soils; Estimation of exchangeable K in soils; Estimation of exchangeable Ca and Mg in soils; Estimation of soil extractable S in soils; Estimation of DTPA extractable Zn in soils; Estimation of N in plants; Estimation of P in plants; Estimation of K in plants; Estimation of S in plants.

Suggested readings

- Introductory Soil Science by Dilip Kumar Das, Kalyani Publishers
- Textbook of Soil Science – by S. K Pal. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi
- Soil Fertility and Nutrient Management by S. S. Singh, Kalyani Publishers
- Soil Fertility and Fertilizers by Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York
- The nature and Properties of Soils by Harry O. Buckman and Nyle C.

AEN 155: Fundamentals of Entomology 3(2+1)

Objectives

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

Theory

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

Practical

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

Suggested readings

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

PPA 156: Fundamentals of Plant Pathology 3(2+1)

Objectives

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

Theory

Introduction to Plant Pathology: Concept and consequences of disease in plant; Different terminologies used inPlant Pathology; History of Plant Pathology with special references to India; **Causes of plant disease:** biotic, meso-biotic and abiotic causes with examples; Classification of plant diseases; Disease Triangle, disease pyramid, Disease cycle, lifecycle; Modes of nutrition - Saprophytism, Parasitism and Mutualism/ Symbiosis; **Pathogenesis and disease development in plant:** events like contact, pre-penetration, penetration and post-penetration/colonization, symptom development and dissemination of inoculum; **Fungi:** importance, characteristics, morphology (vegetative bodies and their modifications), reproductions (vegetative, asexual, sexual, parasexual) nomenclature – binomial and trinomial, classification of fungi up to Classes with Class characteristics; **Bacteria:** Morphology, reproduction classification of phytopathogenic bacteria; **Other plant pathogens:** Mollicutes; Flagellant protozoa; FVB; Green algae and parasitic higher plants; viruses and viroids, virus transmission; **Principles and methods of plant disease management:** Disease management with chemicals, host resistance, cultural and biological method of Integrated Disease Management (IDM).

Practical

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

Suggested readings

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

ASC 157: Livestock and poultry Management 2(1+1)

Objectives

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

Theory

Role of livestock in the national economy. Common animal husbandry terms. Important Indian and exotic breed of cattle, buffalo, sheep, goat, pig and poultry. Improvement of farm animals and poultry. Reproduction in farm animals and poultry. Digestion in livestock and poultry. Classification of feed stuffs. Proximate principles of feed. Feed ingredients for ration for livestock and poultry. Feeding of livestock and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves and milch animals. Incubation , hatching and brooding. Management of layer and broiler birds. Introduction of livestock and poultry diseases. Prevention and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, goat and poultry. Handling and restraining of livestock. Determination of body weight of animals through body measurements. Identification methods of farm animals and poultry. Layout of housing of different types of livestock. Selection of eggs for hatching and study of structure of eggs. Computation of rations for livestock and preparation of concentrated mixture. Formulation of concentrate mixtures. Determination of specific gravity, fat and SNF milk. Detection of common adulterants in milk. Economics of cattle and poultry production.

Suggested Readings

- A Textbook of Animal Husbandry by G. C Banerjee.
- A text Book of Livestock Production management in Tropic by D. N. Verma.

SEC (III) 161: Skill Enhancement course-III: Soil, water and plant testing 2(0+2)

Practical

Basic idea for establishment of a soil, water and plant testing laboratory. Determination of pH, EC, organic carbon, sulphur, macro and micronutrient elements in soil. Irrigation water quality analysis. Determination of pH, EC, carbonates and bicarbonates, calcium and magnesium, sodium, potassium, chlorine and boron in irrigation water. Estimation of macro and micromutrient elements in plant samples. Rapid tissue test for soil and plant analysis. Interpretation and recommendation of the results obtained after soil, water and plant testing.

SEC (III) 162: Skill Enhancement course-III: Commercial Apiculture 2(0+2)

Practical

Acquaintance with bee keeping equipments and handling of bees, Artificial queen rearing, Multiplication of bee colony, Management of bees during different seasons, Extraction of honey and bee wax, Ripening of honey and its quality control, Production of royal jelly, Management of insect and mites of bees, Management of insect and mites of bees.

SEC (III) 163: Skill Enhancement course-III: Orchard floor management 2(0+2)

Practical

Layout of different systems of orchards and Fruit Nutrition Garden. **Soil management practices:** clean cultivation, sod culture, sod mulch, intercropping, cover cropping and mixed cropping. **Use of mulch materials:** organic and inorganic, moisture conservation and weed control. **Layout of various irrigation systems, surface irrigation**: Flood system, basin system, modified basin system, furrowmethod, **sub-surface irrigation systems**: drip irrigation and its components, **overhead irrigation:** sprinkler system, fertigation, Different methods of application of manure and fertilizers, use oforganic manures, Biofertilizers, Green manuring and bio-agents. Visit to orchards of Progressive fruit growers.

SEC (IV) 164: Skill Enhancement course-IV: Agro forestry management (SWC) 2(0+2)

Practical

Agroforestry definitions, objectives, potential and distinction between agroforestry and forestry. Introduction of different types of Agroforestry: A) Agri-silviculture, B) Agri-Horticulture, C) Agri_Horti_Silviculture, D) Agri- silvi-pasture, Visit to the different agroforestry types Nursery bed preparation for forest species, Nursery bed preparation for Horticultural crops, Method of planting/sowing Agroforestry with field crop and vegetable crops. Method of planting/sowing Agroforestry with fruit crops, Tree growth measurement and estimation of tree log/forest biomass, Estimation of yield of different field and fruit crops,Techno-economical feasibility of the three popular agroforestry types (Agri-silviculture, Agri-Horticulture, Agri_Horti_Silviculture).

SEC (IV) 165: Skill Enhancement course-IV: Organic production Technology (AGR) 2 (0+2)

Practical

Preparation of a pre-designed programme plan for establishing organic farm, Selection and treatment of seeds and planting materials in organic system, Nutrient management through organic inputs, Water management and interculture operation , Weed, pest and disease management in organic system of cropping, Harvesting,storing ,packaging and labeling, Organic certification process, Growing various crops with organic package of practices and visit to certified organic farm and Grower group of farmers.

SEC (IV) 166: Skill Enhancement course-IV: Nursery production of horticultural crops 2(0+2)

Practical

Layout of model nursery, Tools and equipment- identification and application. Different methods of breaking seed dormancy stratification, scarification and use of plant growth regulators. Extraction and storage of healthy seeds, seed bed preparation, Identification and raising of rootstocks for different fruit plants, soil solarization, preparation of potting mixtures. Selection of healthy scionwood, practices in different methods of plant propagation like cutting, layering, budding and graftingin fruit plants. Micropropagation- explant preparation, media preparation, culturing–meristem tip culture, axillary bud culture, micro-grafting and hardening of plants. Nursery management practices i.e. weed control, irrigation, nutrition, removal of sprouts etc. Protection of nursery plants against adverse climatic conditions. Protected structures. Diagnosis and control of important diseases and pests in the nursery, lifting and packing of nursery plants, Visit to commercial tissue culture laboratories and accredited nurseries.

SEMESTER III

CC 201: Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

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

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; **Balanced Diet and Nutrition**: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sportsin personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises forgood posture.Yoga; History of Yog, Types of Yog, Introduction to Yog, **Asanas** (Definition and Importance): Padmasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan. **Suryanamskar Pranayama** (Definition and Importance): Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari. **Meditation** (Definition and Importance): Yogic Kriyas (Kapalbhati), Tratak, Jalneti andTribandh. **Mudras** (Definition and Importance): Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. Role of yoga in sports. **Teaching of Asanas**: demonstration, practice, correction and practice.History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specificationsof equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis,Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics Need and requirement of first aid. First Aid equipment and upkeep. First aid Techniques, Firstaid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. Firstaid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with

Poisoning. First aid related with Bites andStings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

AGR 202: Crop Production Technology-I (*Kharif* crops) 3 (1+2*)

Objectives

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

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varities, cultural practices and yield of Kharif crops. Cereals- rice, maize, sorghum, pearl millet and finger millet, pulses- pigeonpea, mungbean and urdbean; oilseeds- groundnut, sesamum and soybean; fibre crops- cotton & jute; forage crops- sorghum, cowpea, and napier.

Practical

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

Suggested Readings

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

AGR 203: Principles and Practices of Natural Farming 2 (1+1)

Objectives

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

Theory

Indian Heritage of Ancient Agriculture, History of Natural Farming, Importance of natural farming in view of climate change, soil health, water use carbon sequestration, biodiversity conservation, food security and nutritional security, and sustainable development goals (SDGs), Concept of natural farming; Definition of natural farming; Objective of natural farming, Essential

characteristics and Principles of natural farming; Scope and importance of natural farming. Main Pillars of natural farming; Methods/ types/schools of natural farming. Characteristics and design of a natural farm, Concept of ecological balance, ecological engineering and community responsibility in natural versus other farming systems, Introduction to concept of ecological, water, carbon and nitrogen foot prints, Concept and evaluation of ecosystem services, Integration of crops, trees and animals, cropping system approaches, Biodiversity, indigenous seed production, farm waste recycling, water conservation and renewable energy use approaches on a natural farm, Rearing practices for animals under natural farming**,** Nutrient management in natural farming and their sources, Insect, pest, disease and weed management under natural farming; Mechanization in natural farming, Processing, labelling, economic considerations and viability, certification and standards in natural farming , marketing and export potential of natural farming produce and products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of natural farming and chemical free agriculture, Case studies and success stories in natural farming and chemical free traditional farming, Entrepreneurship opportunities in natural farming.

Practical

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

Suggested readings

- Ayachit, S.M. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). BrigSayeed Road, Secunderabad, Telangana: Asian Agri-History Foundation 4: 205.
- Boeringa, R. (Eed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199pp.
- Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
- Ecological Farming -The seven principles of a food system that has people at its heart. May2015, Greenpeace.
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- Nalini, S. 2011. Upavana Vinoda (Woodland Garden for Enjoyment) by Sarangdhara (13thcentury CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Brig Sayeed Road,Secunderabad, AP (now Telangana), India. 64p.
- Natural Asset Farming: Creating Productive and Biodiverse Farms by David B. Lindenmayer, Suzannah M. Macbeth, et al. (2022).
- Natural Farming Techniques: Farming without tilling by Prathapan Paramu (2021).
- Plenty for All: Natural Farming A to Z Prayog Pariwar Methodology by Prof. Shripad A. Dabholkar and Prayog Pariwar (2021).
- Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has peopleat its heart. Greenpeace Research laboratories. University of Exeter, Ottho Heldringstraat.Shamasastry, R. 1915. Kautilya's Arthashastra.
- The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners(Ultimate Guides) by Nicole Faires (2016).
- U. K. Behera. 2013. A text Book of Farming System. Agrotech Publishing House, Udaipur.

GPB 204: **Principles of Genetics 3(2+1)**

Objective

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

Theory

Pre and post Mendelian concepts of heredity, Mendelian principles of heredity, Architecture of chromosomes, chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere, special tpes of chromosomes, Chromosomal theory of inheritance- cell cycle and cell division-mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example. Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanism, chromosome mapping, Structural and numerical variations in chromosomes and their implications, Use of haploids, dihaploids and double haploids in Genetics, Mutation, classification, Methods of inducing mutations and CIB technique, mutagenic agents and induction of mutation. Qualitative and quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance, Genetic disorders, Nature, structure and replication of genetic material, Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope, Stud of cell structure, Mitosis and Meiosis cell division, Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on

probability and chi-square test, Determination of linkage and croo-over analsis (through two point test cross and three point test cross data), Study on sex linked inheritance in Drsoophila. Study on models on DNA and RNA structures.

Suggested readings

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

AEN 205: **Fundamentals of Nematology 2(1+1)**

Objectives

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

Theory

Introduction: History of phytonematology, habitat and diversity, economic importance of nematodes. General characteristics of plant parasitic nematodes. Nematode: definition, general morphology and biology. Classification of nematodes up to family level with emphasis on groups containing economically important genera. Classification of nematodes on the basis of feeding/parasitic habit. Symptomatology, role of nematodes in disease development, Interaction between plant parasitic nematodes and disease-causing fungi, bacteria and viruses. Nematode pests of crops: Rice, wheat, vegetables, pulses, oilseed and fiber crops, citrus and banana, tea, coffee and coconut. Different methods of nematode management: Cultural methods, physical; methods, Biological methods, Chemical methods, Plant Quarantine, Plant resistance and INM.

Practical

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

Suggested readings

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

AEX 206: **Fundamentals of Extension Education 2 (1+1)**

Objectives

- State the importance of extension education in agriculture.

- Familiarize with the different types of agriculture and rural development programs launchedby govt. of India.
- Classify the types of extension teaching methods.
- Explain the process and stages of adoption along with adopters' categories.

Theory

Education: Meaning, definition and Types; **Extension Education**: meaning, definition, scopeand process; objectives and principles of Extension Education; **Extension Programme planning**: Meaning, Process, Principles and Steps in Programme Development. **Extension systems in India**: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); Reorganised Extension System (T&V system) various extension/ agriculture development programs launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP,NAIP, etc.). **Social Justice and poverty alleviation programme**: ITDA, IRDP/SGSY/NRLM. **Women Development Programme**: RMK, MSY etc. **New trends in agriculture extension**: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc., Attributes of Innovation, DWCRA, Commodity Interest Groups (CIGs)., Farmers ProducerGroup (FPG). **Rural Development**: concept, meaning, definition; various rural development programslaunched by Govt. of India. **Community Development**: meaning, definition, concept and principles, **Extension administration**: meaning and concept, principles and functions. **Monitoring and evaluation**: concept and definition, monitoring and evaluation of extension programs; **transfer of technology**: concept and models, capacity building of extension personnel; **extension teaching methods**: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies; Agriculture journalism; **diffusion and adoption of innovation**: conceptand meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; Identificationof rural leaders in village situation; preparation and use of AV aids, preparation of extensionliterature (leaflet, booklet, folder, pamphlet news stories and success stories); Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA/PRI andother development departments at district level; visit to NGO/FO/FPO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning.

Suggested Readings

- Mondal Sagar 2017. Fundamentals of Agricultural Extension Education, Kalyani Publishers, Ludhiana.
- Ray, G. L. -Extension Communication and Management , Kalyani Publishers, Ludhiana.
- Sagar Mondal and Das S 2016. Agricultural Extension and Rural Journalism, Kalyani Publishers, Ludhiana.
- Sagar Mondal and Ray, G. L., Text Book on Rural Development, Entrepreneurship and
- Communication Skills, Kalyani Publications.
- Adivi Reddy, A. 2001. Extension Education, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O.P. 1998. Education and Communication for Development, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Rathore, O. S. et al. 2012. Handbook of Extension Education, Agrotech Publishing Academy, Udaipur.

AEC 207: Principles of Agricultural Economics and Farm Management 2(2+0)

Objectives

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

Theory

Economics: Meaning, Scope and subject matter, definitions, activities, approaches to economic analysis, Micro- and macro – economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts, Goods and services, desire, went,demand, utility, cost and price, wealth, capital, income and welfare, resource economics.
Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country.
Demand: meaning, law of demand, demand schedule and demand curve, determinants, utility theory, Law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve.
Concept of consumer surplus: Elasticity of demand concept and measurement of price elasticity, income.
Production: process, creation of utility, factors production,input output relationship.Laws of returns,law of variable proportions and law of returns to scale.
Farm Management: Definition and concepts, Principles of Farm Management, CACP Cost Concepts, MSP and Farm Business Analysis.
Cost: Cost concepts, short run and long run cost curves.
Supply: Stock v/s supply, law of supply, supply schedule,supply curve, determinants of supply,elasticity of supply.
Distribution theory: meaning, factor market and pricing of factors of production concepts of rent, wage, interest and profit.
National income: Meaning and importance circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement.
Population: importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programs on population control.
Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation.
Economic systems: concepts of economy and its functions, important features of capitalistic socialistic and mixed economies elements of economic planning.
Forms of business organizations: international trade and balance of payments. GST and its implication on Indian economy.

Suggested Reading

- Johl, S. S. and T.R. Kapur. 2009. Fundamentals of Farm Business Management, KalyaniPublisher.
- S. Subha Reddy, P. Raghu Ram, T.V. Neelakanta and l. Bhvani. 2004. Agricultural Economics. Oxford & IBH Publishing co. Pvt. Ltd.

HORT (A) 208: Production Technology of Fruit and Plantation Crops 2 (1+1)

Objectives

- To educate about the different forms of classification of fruit crops.

- To educate about the origin, area, climate, soil, improved varieties and cultivation practices offruit and plantation crops.
- To educate about the physiological disorders of fruit crops, palms and plantation crops.

Theory

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

Practical

Propagation techniques, selection of planting material, varieties, important cultural practicesfor mango, banana, papaya, guava, sapota, grapes, Citrus (mandarin and acid lime), pomegranate, jackfruit, preparation an application of PGR's for propagation, Micro propagation, protocol formass multiplication and hardening of fruit crops, Identification and description of varieties, motherpalm and seed nut selection, nursery practices, seedling selection, fertilizers application, nutritionaldisorders, pests and diseases of Coconut, Arecanut and cocoa, Tea and coffee, Rubber and cashew,Visit to commercial orchard and plantation industries.

Suggested Readings

- Banday, F.A. and Sharma, M.K.2010 Advances in temperate fruit production. KalyaniPublishers, Ludhiana.
- Bose, T.K., S.K. Mitra and D. Sanyal 2001. Fruits: Tropical and Subtropical (2 volumes) NayaUdyog, Calcutta.
- Bose, T.K., S.K. Mitra, A.A. Farooqi and M.K. Sadhu (Eds). 1999. Tropical Horticulture Vol.1.Naya Prokash, Calcutta.
- Chadha, K.L. 2001. Handbook of Horticulture. ICAR, Delhi.
- Chadha, T.R. 2001 Textbook of temperate fruits. ICAR, New Delhi.
- Chattopadhyay, T.K. 2001. A Text Book on Pomology (4 volumes). Kalyani Publishers, Ludhiana.
- Chattopadhyay. 1998. A textbook on pomology (sub-tropical fruits) vol.III. Published by M/s.Kalyan publishers, Ludhiana, New Delhi, Noida. UP.
- Chudawat, B. S.1990. Arid fruit culture Oxford &IBH, New Delhi.
- Das, B.C. and Das S.N. Cultivation of minor fruits. Kalyani Publishers, Ludhiana.
- David Jackson and N.E. Laone, 1999. Subtropical and temperate fruit production. CABIpublications.
- H.P. Singh and M.M. Mustafa 2009. Banana-new innovations Westville publishing House, NewDelhi.

- Kumar, N. 1997. Introduction to Horticulture. Rajalakshmi Publications, Nagercoil, TamilNadu.
- Mitra, S.K., T.K. Bose and D.S. Rathore. 1991. Temperate fruits. Horticulture and alliedPublishers, Calcutta.
- Pal, J.S. 1997. Fruit Growing. Kalyani Publishers, New Delhi.
- Radha, T. and Mathew, L.2007. Fruit crops. New India publishing Agency.
- Rajput, CBS and Srihari babu, R.1985. Citriculture, Kalyani Publishers, Ludhiana.
- Sadhu, M.K. and P.K. Chattopadhyay. 2001. Introductory Fruit Crops. Naya Prokash, Calcutta.
- Singh, S.P. 2004. Commercial Fruits. Kalyani Publishers, Ludhiana.
- Symmonds. 1996. Banana, II Edn.Longman, London.
- Veeraragavathatham, D., Jawaharlal, M., Jeeva, S., Rabindran, R and Umapathy, G. 2004(2nd edition). Scientific fruit culture. Published by M/s. Suri associates, 1362/4, Velraj ViharComplex, Thadagam Road, Coimbatore- 2.
- W.S. Dhillon. 2013. Fruit production in India. Narendra publishing House, New Delhi.
- Kavino, M, V. Jegadeeswari, R. M. Vijayakumar and S. Balkrishnan. 2018. ProductionTechnology of Fruits and Plantation Crops by Narendra Publishing House.
- Kumar, N.J. B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction tospices, Plantation crops and Aromatic plants. Oxford & IBH, New Delhi.
- Nair. 1979. Cashew, CPCRI, Kerela.
- Sharma, A., Kumar, P., Tripathi, V.K. 2024. Production Technology of Fruits and PlantationCrops. Elite Publishing House.
- Thampan, P.K.1981. Handbook of coconut palm. Oxford &IBH, New Delhi.
- Thompson, P.K.1980. Coconut. Oxford &IBH, New Delhi.
- V. Ponnuswami, M. Kumar; S. Ramesh Kumar and C. Krishnamoorthy 2015. Fruit andPlantation Crops Narendra Publishing House.

AEG 209: Farm Machinery and Power 2(1+1)

Objectives

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

Theory

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

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine; Familiarization with clutch, transmission, differential and final drive of a tractor; Familiarization with lubrication and fuel supply system of engine; Familiarization with brake, steering, hydrauliccontrol system of engine; Learning of tractor driving; Familiarization with operation of

power tiller; Implements for hill agriculture; Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow; Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and trans planter; Familiarization with different types of sprayers and dusters; Familiarization with different inter-cultivation equipment; Familiarization with harvesting and threshing machinery; Calculation of power requirement for different implements.

Suggested readings

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

SEC (V) 211: Skill Enhancement course-V: Production Technology of Bio-agents 2(0+2)

Practical

Introduction to biological control. Types of biocontrol agents. Facilities required in general for mass production of natural enemies and biopesticides. Mass rearing of fictitious host insects of biocontrol agents on natural or artificial diets.

a) *Corcyra cephalonica*, b) *Spodoptera litura*, c) *Helicoverpaarmigera*, d) Mealy bugs, e) *Galleria mellonella*.

Mass production of biocontrol agents (Any two groups): A. Mass production of predatory and parasitic group of insect: a) *Trichogramma chilonis/T. japonicum*, b) *Bracon brevicornis c) Telenomus* sp. *d*) *Chrysoper lacarnea* or *Mallda* sp. e) *Cheilomenes sexmaculata* or *Scymnus*(*Pullus*) *posticalis* or *Serangium parcesetosum*, f) *Rhynocoris marginata g) Blaptostethus pallescens* or *Orius* sp. B. Mass production of weed feeding insect herbivore – *Zygogranma bicolorata.* C. Mass production of entomopathogenic nematode –*Heterorhabditis* sp. or *Steinernema* sp. D. Mass production of HaNPV or SlNPV. Quality assurance, field release or application. Economics involved in commercial production - Benefit Cost Ratio.

SEC (V) 212: Skill Enhancement course-V: Production of Botanical Pesticides 2(0+2)

Objective

- Skill development for Bio-Pesticide Production for eco-friendly crop protection

Practical

Introduction, Types of bio-pesticides, Bio-pesticide market, Botanicals as bio-pesticides; Principle & techniques of extraction of bio-active constituents from plants (Selection and collection of plants, drying and grinding, solvent extraction and evaporation); Basic principle and techniques of solid (WP) and liquid (EC) formulation production (Carriers, diluents, solvents & surfactant selection and optimization); Formulation and packaging of solid (WP) and liquid (EC) formulations; Quality assurance of WP/EC formulations (pH range; Emulsion Stability and re-emulsification; Wet Sieve Test; Suspensibility; Persistent Foam; Wettability, Accelerated Storage Stability,etc.); Economics involved in commercial production; Benefit cost ratio; Registration of botanical pesticides; Marketing strategy: product promotion and sale.

Suggested Readings

- Leo ML, Nollet and Rathore HS. 2017. Green Pesticides Handbook: Essential Oils for Pest Control (ISBN-13: 978-1498759380), CRC Press, pp 570.
- Parmar BS and Devakumar C. 1990. Botanical and Biopesticides. Westvill Publ. House.
- Teicher HB. 2017. Pesticides and Biopesticides: Formulation and Mode of Action (Publisher: BioComm Press), pp 166.
- Valkenburg WV. 2008. Pesticide Formulation: Recent Developments and Their Applications in Developing Countries (ISBN-13: 978-8122410693), New Age International (P) Limited, Publishers; First edition (2008) pp 488.

SEC (V) 213: Skill Enhancement course-V: Post Harvest Management of Horticultural crops 2(0+2)

Layout and planning of postharvest experiments, Maturity and harvesting of horticultureproduce. Judging maturity by different methods. Harvesting tools. Objective measurement of colour, texture and dry matter. Components and equipment used in Postharvest laboratory, Different types of cleaning agents and washing methods for horticultural produce. Layout of packhouse and General packhouse operation. Sorting, surface sanitizing and drying of fruit. Postharvest treatments for shelf life extension of fruits and vegetables. Packing of fruits in different packaging materials, preparationof different coating materials and their method of applications. Pre-cooling of horticultural produce. Ripening technology for horticultural crops. Significance of sorting and grading in horticulture produce: Types of grading system and standards. Cold-chain management. Storage requirements. Commercial technologies for processing of horticultural produce.

SEC (V) 214: Skill Enhancement course-V: Seed production and Processing Technology 2(0+2)

Objectives

- Development of students' skill in crop seed production

Practical

Field visit during seed production in the farm; Receiving of harvested farm seeds considering different steps; Seed drying techniques; Pre-cleaning, Fine cleaning of seeds, Grading; Seed sampling and seed quality analysis through different tests; Seed treatment practices considering different types (like pesticide, insecticide and fungicides); Types of seed packaging materials, appropriate quantity of seed, Storage of Seed; Visit Seed processing plant and layout.

SEC (V) 215: Skill Enhancement course-V: Molecular Data Analytics (ABT) 2(0+2)

Objectives

- To help the student to achieve soft skill for handling biological data and its analysis

Practical

Collection of data , Tabular representation of data, Graphical representation of data, Use of MS-Excel for data analysis, Preparation of binary data after Gel electrophoresis, DNA Marker parameter analysis with binary data using MS-Excel, Cluster Analysis using binary data, **Biological Database Searching**: NCBI, PDB, **Database Similarity Searching**: BLAST, Pair wise **Sequence Alignment tools**: EMBOSS, **Multiple Sequence Alignment tool**: Clustal Omega, Tools for DNA Sequence analysis, Tools for Protein sequence analysis, Visualization tools for Protein 3D structure.

Suggested Readings

- Attwood, T.K.,andParry-Smith,D.J. 2004.Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
- David Edwards (Ed.) 2007. Plant Bioinformatics: Methods and Protocols. Humana Press, New Jersey, USA.
- XiongJ.2012. Essential Bioinformatics, Cambridge University Press.
- Ewens W.J and Grant G.R. 2001. Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health). Springer.
- Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
- Panse VG and Sukhatme PV. 1983. Statistical Methods for Agricultural Workers, ICAR.
- Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.

SEMESTER IV

CC 251: Agricultural Informatics and Artificial Intelligence 3(2+1)

Objective

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

Theory

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

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management. Use of MS-Word and MS Power-point for creating, editing and presentinga scientific documents, MS-EXCEL-Creating a spreadsheet, Use of statistical tools, Writingexpressions, Creating graphs, Analysis of scientific data, MS-ACCESS: Creating Database, preparingqueries and reports, Demonstration of Agri- information system, Introduction to World Wide Web(WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/CropSyst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of waterand nutrient requirements of crop using CSM and IT tools, Use of smartphones and other devices inagro-advisory and dissemination of market information, Introduction of Geospatial technology, AR/VR demonstration, Preparatio of contingent crop planning, India Digital Ecosystem of Agriculture(IDEA).

Suggested Readings

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

CC 252: Entrepreneurship Development and Business Communication 3 (2+1)

Objective

- To provide student an insight into the concept and scope of entrepreneurship.
- To expose the student to various aspects of establishment and management of a small businessunit.
- To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. **Environmentscanning and opportunity identification need for scanning**: spotting of opportunity, scanning ofenvironment identification of product / service: starting a project; factors influencing sensing the opportunities. **Infrastructure and support systems**: good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection ofform of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. **Production management**: product, levels of products, product mix, quality control, cost of production, production controls, Material management. **Production management**: raw material costing, inventory control. **Personal management**: manpower planning, labour turn over, wages / salaries. **Financial management /accounting**: funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. **Marketing management**: market,

types, marketing assistance, market strategies. **Crisis management**: raw material, production, leadership, market, finance, natural etc.

Practical

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

Suggested Readings

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

AGR 253: Crop Production Technology-II (*Rabi* Crops) 3(1+2)

Objectives

- To impart basic and fundamental knowledge on principles and practices of rabi crop pdn.
- To impart knowledge and skill on scientific crop production and management.

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of Rabi crops; cereals- wheat, Potato, pulses- chickpea, lentil, peas, lathyrus, oilseed-rapeseed, mustard, sunflower and safflower; sugar crops-sugarcane; medicinal and aromatic crops- mentha, lemon grass and citronella, Forage crops –berseem, lucerne and oat.

Practical

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

Suggested Readings

- Gurarajan, R. Balasubramanian and V. Swaminathan. Recent Strategies on Crop Production.Kalyani Publishers, New Delhi.
- Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.

- Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICARPublication.
- Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICARPublication.
- S.R. Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
- S.S. Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
- Rajendra Prasad. 2002. Text Book of Field Crops Production, ICAR, New Delhi.
- Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
- Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South AsianPublishers, New Delhi.
- UAS, Bangalore. 2011. Package of Practice. UAS, Bengaluru.

AGR 254: Water Management 2 (1+1)

Objectives

- To study the important properties of soil affecting water availability to crops and water requirement for optimum growth and development
- To study different methods of irrigation and water management practices of both field and horticultural crops and drainage.
- To study the soil moisture conservation practices including management of rain water, watershed and command areas

Theory

Irrigation: definition and objectives, Importance function of water for plant growth, water resources and irrigation development for different crops in India; Soil plant water relationships; Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern, effect of moisture stress on crop growth. Methods of soil moisture estimation, evapotranspiration and crop water requirement; effective rainfall, different approaches of scheduling of irrigation; Methods of irrigation: surface and sub-surface, pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water; Layout of different irrigation systems, Irrigation efficiency and water use efficiency, conjunctive use of water, irrigation water quality and its management. Water management of different crops (rice, wheat, maize, groundnut, sugarcane, mango, banana and tomato); Agricultural drainage. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops., drip, sprinkler. Layout of underground pipeline system.

Practical

Determination of bulk density by field method; Determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; Determination of field capacity by field method; Determination of permanent wilting point; Measurement of irrigation water by using water measuring devices viz., flumes and weirs; Calculation of irrigation water requirement (Problems); Determination of infiltration rate; Demonstration of furrow method of irrigation; Demonstration of check basin and basin method of irrigation; Visit to farmers field and cost estimation of drip irrigation system; Demonstration of filter cleaning, fertigation, injection and flushing of laterals; layout for different methods of irrigation, Erection and operation of sprinkler irrigation system; Measurement of emitter discharge rate, wetted diameter and calculation of emitter discharge variability; Determination of EC, pH, carbonates, bio-carbonates, Ca++ and Mg++ in irrigation water (quality parameters).

Suggested Readings

- Rao, Y.P. and Bhaskar, S.R. Irrigation technology. Theory and practice. Agrotech publishingAcademy, Udaipur.
- Dilipkumar Mujmdar. Irrigation water management: Principles and Practices. Prentice Hall ofIndia Pvt. Ltd.
- S.V. Patil &Rajakumar, G. R., Water Management in Agriculture and Horticultural Crops.Satish serial publishing House, Delhi.
- Carr M. K. V. and Elias Fereres. Advances in Irrigation Agronomy. Cambridge UniversityPress.
- Michael, A.M. Irrigation Theory and practice. Vikas publishing house Pvt, Ltd.

ACSS 255: Problematic Soils and their management 2 (1 + 1)

Objectives

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

Theory

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

Practical

Determination of pHs and EC of saturation extract of problematic soil. Determination of redox potential in soil, Estimation of water soluble and exchangeable cations in soil and computation of SAR and ESP and characterization of problematic soil. Determination of Gypsum requirement of alkali / sodic soil. Determination of lime requirement of acidic soil. Determination of Quality of irrigation water (pH, EC, Ca, Mg, Na, CO_3^{2-}, HCO_3^-, Cl, SAR and RSC), Determination of nitrate (NO^{3-}) from irrigation water, Determination of dissolved oxygen and free carbon dioxide levels in water samples.

Suggested readings

- Saline Alkali soils of India - by Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). ICAR, AGROBIOS (India).
- Nature and properties of soils - by Brady Nyle C and Ray R Well., 2014. Pearson Education Inc., New D Delhi.
- Principles of Remote Sensing. – by Cirsan J. Paul., 1985,. Longman, New York.
- Fundamentals of Soil Science - by Indian Society of Soil Science., 2002.. IARI, New Delhi.
- Introductory Soil Science – by Dilip Kumar Das, Kalyani Publishers.

GPB 256: Basics of Plant Breeding 3 (2+1)

Objectives

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

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in rlation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male-sterility-genetic consequences, cultivar options, Domestication, Acclimatization and Introduction; Centres of origin/diversity, Components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self pollinated crops-mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept, Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross-pollinated crops, modes of selection; Population movement schemes-Ear to Row method, Modified Ear to Row, recurrent selection schemes; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Maintenance of breeding records and data collection; 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; Intellectual Propert Rights, Patenting, Plant Breeders & Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops, Study of floral structures of self-pollinated and cross pollinated crops, Emasculatiopn and hybridization techniques in self & cross pollinated crops, Consequences of inbreeding on genetic structure of resulting populations, Study of male sterility system, Handling of segregating populations, Mathods of calculating mean, range, variance, standard deviation, heritability, Designs used in plant breeding experiments, analysis of Randomized Block Design, To work out the mode ofpollination in a given crop and extent of natural out-crossing, Prediction of performance of double cross hybrids.

Suggested readings

- Principles of Plant Breeding (1st & 2nd Edition) by RW Allard.
- Plant Breeding: Principles & Practices by JR Sharma.
- Plant Breeding- B.D. singh.
- Principles and Procedures of Plant Breeding - Biotechnical and Conventional Approachesby GS Chahal andSS Gosal.
- Principles of Plant Genetics and Breeding by George Acquaah.

ACH 257: Basic concept on Pesticides 2(1+1)

Objectives

- To impart knowledge on the nature of pesticides used for crop protection and other purposes, their formulation type, residual fate and safety.

Theory

Introduction to Pesticides: definition, history, classification, toxicity;Pesticide Registration and Banning; **Pesticide poisoning**: basic precautions in pesticide handling, antidotes for pesticides; Use pattern of Pesticides in Plant Protection, other uses of pesticides; Concept on pesticide formulation: active ingredient and adjuvants like carrier, diluent, surfactant; Solid and liquid formulations, formulation code; Chemical class, use, mode of action and formulation type of some popular pesticides (DDT, Chlorpyrifos, Carbofuran, Cypermethrin, Imidacloprid, Novaluron, Fipronil, Carbendazim, Hexaconazole, 2,4-D, Glyphosate, Fenazaquin, Nemagon, Zinc Phosphide, Methiocarb, Alpha-napthylacetic acid, and Thiabendazole); **Bio-Pesticides**: Types, uses, mode of action and formulation type; **Introduction to Pesticide Residues**: Residual fate, dissipation and persistence; Significance of pesticide residue analysis; Steps involved in residue analysis; Residual safety: MRL, PHI.

Practical

Identification and familiarizations with the basic apparatus and equipment used in pesticide laboratory; Identification of different formulation with toxicological pattern; Estimation of active ingredient in some organic and inorganic pesticides; Test for Emulsion stability of EC formulation; Test for suspensibility of WP formulation; Collection, processing and preservation of sample for pesticide residue analysis.

Suggested Reading

- Handa SK, Agnihotri NP and Kulshrestha G. 1999. Pesticide Residues: Significance, Management and Analysis. Research Periodicals & Books Publishing House, 226p.
- Larramendy, M.L. 2017. Toxicity and Hazard of Agrochemicals, INTECH, 170p.
- MathewsG.A. (Ed). 2016. Pesticides: Health, Safety and the Environment, 2nd Edition, ISBN: 978-1-118-97602-9, Wiley-Blackwell.
- Ohkawa H, Miyagawa H and Lee PW. (Ed). 2007. Pesticide Chemistry: Crop Protection, Public Health, Environmental Safety. DOI: 10.1002/9783527611249, Wiley VCH Verlag GmbH & Co. KGaA, pp 489.
- Valkenburg WV. 2008. Pesticide Formulation: Recent Developments and Their Applications in Developing Countries (ISBN-13: 978-8122410693) New Age International (P) Limited, Publishers; First edition (2008) pp 488.

Hort (A) 258: Production Technology of Vegetables and Spices 2(1+1)

Objectives

- To educate about the different forms of classification of vegetables.
- To educate about the origin, area, climate, soil, improved varieties and cultivation practices ofvegetables and spices.
- To educate about the physiological disorders of vegetables and spices.

Theory

Importance of vegetables and spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices suchas time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of important vegetable and spices (tomato, okra, brinjal, chili, capsicum, cucumber, bitter gourd , bottle gourd, sweet potato, cassavaand moringa, pumpkin, French bean, peas; cole crops such as cabbage, cauliflower, knol-khol; bulbcrops such as onion, garlic; root crops such as carrot, radish, beetroot; tuber crops such as potato; leafy vegetables such as amaranth, palak, perennial vegetables, spice

crops like turmeric, zinger,garlic, coriander, cumin, black pepper, cardamom, fenugreek, fennel, clove, nutmeg, cinnamon, curry leaf, tamarind and herbal spices).

Practical

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

Suggested readings

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

SEC (VI) 261: Skill Enhancement course-VI: Micropropagation technologies2(0+2)

Objectives

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

Practical

Identification and use of equipments in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for explants, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, indirect regeneration of whole plants from different explants, Primary and secondary hardening procedures.

Suggested readings

- Plant Tissue Culture: Basic and Applied by Timir Baran Jha and Biswajit Ghosh, 2016, Platinum Publishers, 439p.
- Plant Tissue Culture: Theory & Practice by S.S. Bhojwani & M.K. Razdan, 1996, Elsevier.

SEC (VI) 262: Skill Enhancement course-VI: Landscape gardening 2 (0+2)

Identification and use of garden tools and equipment. Study of growth characters, identification and classification of ornamental trees, shrubs, climbers, ground covers and indoor plants. Making and maintenance of edge, hedge and topiary. Establishment and maintenance of a lawn. Bonsai making. Art principles of landscaping. Formal and informal gardens. Planning, designing andestablishment of garden features. Landscape design process: Landscape drafting tools. Dimensioning, graphic symbols and notations. Site analysis and landscape designing of residential, public buildings and religious places. Landscape planning of roads and roundabouts. Visit to community parks and Institutional gardens.

SEC (VI) 263: Skill Enhancement course-VI: Biofertlizer Production Technology 2(0+2)

Practical

Acquaintance with the Development biofertilizer production unit. Types of biofertiliaers. Production technology: Isolation and purification of *Azospirillum, Azotobacter, Rhizobium*, P-solubilizers and cyanobacterial biofertiliaer; preparation of culture media and sterilization, mass culturing of microbial inoculants in fermenter. Preparation of carrier based and liquid biofertiizers. Quality control of biofertilizers. Methods of biofertilizer application.

SEC (VI) 264: Skill Enhancement course-VI: Production of Microbial Biocontrol agents 2(0+2)

Scope and importance of microbial biocontrol agents in agriculture. Status of microbial biocontrol agents' production and marketing. Acquaintance with microbial biological control agents mainly *Trichoderma, Bacillus* and *Pseudomonas fluorescence*. Biocontrol laboratory facilities required for mass production of biological control agents. Media used for isolation, numeration, purification and maintenance of biocontrol agents. Different methods for identification of biocontrol agents. Assay for antagonistic activity and plant growth promotion potentiality of biocontrol agents. Mass production of biocontrol agents. Quality control of biocontrol agents, Economics involved in commercial production. Benefit Cost ratio. Method of applications of biocontrol agents. Registration of biocontrol agents. Marketing strategy - product promotion and sale.

SEMESTER V

CC 301: Agricultural Marketing and Trade 3 (2+1)

Objectives

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

Theory

Agricultural Marketing concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets, **Demand, supply and producer's surplus of agri-commodities**: nature and determinants of demand and supply of farm products, producer's surplus of agri-commodities. Pricing and promotion strategies pricing considerations and approaches, cost-based and competition based pricing; Market promotion, advertising, personal selling sales promotion and publicity-meaning, **merits and demerits**: Marketing process and functions, Marketing process concentration, dispersion and equalization, exchange functions; buying and selling physical functions storage, transport and processing facilitating functions – packaging, branding, grading, quality control and labelling (Agmark), Market functionaries and marketing channels; Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; Marketing channels for different farm products; Integration, efficiency, **costs and price spread**: Meaning, definition and types of market integration; marketing efficiency marketing costs margins and price spread, factors affecting cost of marketing reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: public sector institutions –CWC, SWC,FCI, CACP and DMI- their objectives and functions; cooperative marketing in India. **Risk in marking:** Types of risk in marketing; speculation and hedging; an overview of futures trading; **Agricultural prices and policy:** Meaning and functions of price; administered prices; need for innovations in

agricultural price policy; **Trade:** Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities,WTO, Agreement on Agriculture (AOA) and its implications on Indian agriculture; IPR, Role of government in agricultural marketing; Role of APMC an its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities study of relationship between market arrivals and price of some selected commodities, computation of marketable and marketed surplus of important commodities, study of price behavior over time for some selected commodities, construction of index number, 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 institution –NAFED, SWC,CWC, cooperative marketing society etc. to study their organization and functioning application of principles of comparative advantage of international trade.

Suggested readings

- Acharya, S.S. and Agarwal N.L.2006 Agricultural Marketing in India, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Chinna S.S. 2005 Agricultural Economics and Indian Agricultural Kalyani Pub, N.Delhi.
- Dominic Salvatore Micro Economic Theory.
- Kohls Richard L. and Uhl Josheph N.2002 Marketing of Agricultural products, Prentice – Hall of India private Ltd, New Delhi.
- Kotler and Armstrong 2005 principles of Marketing. Pearson Prentice Hall.
- Lekhi R. K. and Joginder Singh 2006 Agricultural Economics. Kalyani publishers, Delhi.
- Memorial C.B. Joshi R.L. and Mulla N.I. 2003 principles and practice of Marketing in India Kitab Mahal, New Delhi.
- Pandey Muhesh and Tewari , Deepali 2004 Rural and Agricultural Marketing international Book Distributing Co. Ltd, New Delhi.
- Sharma R. 2005 Export Management Laxmi Narain Agarwal, Agra.

AGR 302: Weed Management 2 (1+1)

Objectives

- To teach students about principles of weed science
- To impart practical knowledge of weed management in field and horticultural crops

Theory

Introduction to weeds, characteristics of weeds; their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds, crop-weed completion, factors of competition, losses on growth and yield of crops; factors affecting growth and development. Concepts of weed management: physical, cultural, chemical and biological; principles and methods, integrated weed management, Implements for weed control, robotic weed control, weed management in organic/ natural farming. Herbicide classification and properties of important herbicides, concept of adjuvants, surfactants, herbicide formulation and their use. Mode of action of herbicides and selectivity phenomenon. Concept of herbicide mixture and utility in agriculture, Herbicide compatibility with agro-chemicals and their application, Herbicide resistance and its management. Weed management in different field and horticultural crops; aquatic weed management.

Practical

Techniques of weed preservation, Weed identification and losses caused by weeds. Biology of important weeds. Study weeds in different situations, Study on shift in weed flora in long term trials, Study of herbicide formulations and mixture of herbicide. Study methods of herbicide application, Herbicide spraying equipments, their parts, use and maintenance. Weed control implements, Calculation of herbicide doses and requirement, weed control efficiency and weed index.

Suggested Readings

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

AEN 303: Pest management in crops and stored grains 3 (2+1)

Objectives

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

Theory

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

Practical

Field visit, identification of major insect pests and their damage symptoms. Collection and preservation of major insect pests; collection of damage samples, their identification and

herbarium preparation. Methods of monitoring of pest incidence in situ. Management strategies of insect pests of different crops. Study on structural entomology and household pests. Storage structures and methods of grain storage. Spraying techniques for selected field and horticultural crops. Vertebrate pest management. Mass multiplication of NPV and entomopathogenic nematodes.

Suggested readings

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

PPA 304: Diseases of Field and Horticultural Crops and their Management 3 (2+1)

Objectives

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

Theory

Symptoms, etiology, disease cycle, epidemiology and management of major diseases of the following field and horticultural crops-

Field crops: Rice (blast, brown spot, sheath blight, false smut, bacterial leaf blight, bacterial leaf streak, tungro, khaira); Wheat (rusts, loose smut, Karnal bunt); Maize (banded leaf and sheath blight, southern and northern blight, downy mildew); Sorghum (smuts, grain mold, anthracnose); Bajra (downy mildew, ergot) and Finger millet (blast, leaf spot); Groundnut (early and late leaf spots, rust, wilt); Soybean (*Rhizoctonia* blight, bacterial spot, seed and seedling rot, mosaic); Grams (*Ascochyta* blight,wilt, grey mold); Pea (downy mildew, powdery mildew, rust); Black gram and Green gram (web blight, anthracnose, *Cercospora* leaf spot, yellow mosaic); Sugarcane (red rot, ratoon stunting, smut, grassy shoot, Pokah Boeng); Mustard (*Alternaria* blight, white rust, downy mildew, *Sclerotinia* stem rot) and Sunflower (*Sclerotinia* stem rot,*Alternaria* blight); Cotton (anthracnose, vascular wilts, black arm).

Horticultural crops: Citrus (canker, gummosis) and Guava (wilt, *Pestalotia* blight, anthracnose); Banana (sigatoka, Panama wilt, bacterial wilt, bunchy top); Papaya (foot rot, mosaic, leaf curl,) and Pomegranate (bacterial blight); Apple (scab, powdery mildew, fire blight, crown gall) and Peach (leaf curl); Grapevine (downy mildew, powdery mildew, anthracnose) and Strawberry (leaf spot); Coconut (bud rot, *Ganoderma* wilt,), Tea (blister blight) and Coffee (rust); Mango (anthracnose, malformation, powdery mildew, bacterial blight); Potato (early and late blight, black scurf, leaf roll, mosaic,) and Tomato (wilt, early and late blight, leaf curl, mosaic damping

off,); Brinjal (*Phomopsis* blight and fruit rot, *Sclerotinia* blight, bacterial wilt) and Chilli (anthracnose and fruit rot, wilt, leaf curl); Cucurbits (powdery and downy mildew,) and Cruciferous vegetables (*Alternaria* leaf spot, black rot, cauliflower mosaic); Beans (anthracnose, bacterial blight) and Okra (yellow vein mosaic); Ginger (soft rot), Turmeric (leaf Spot) and Coriander (stem gall); Rose (dieback, black leaf spot, powdery mildew) and Marigold (botrytis blight, leaf spots).

Practical

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

Suggested Readings

- Integrated Plant Disease Management By R.C. Sharma.
- Plant Diseases By R.S. Singh.
- Plant Disease Management: Principles and Practices By Hriday Chaube.
- Plant Pathology By G.N. Agrios.

GPB 305: **Crop Improvement (*Rabi* crops) II 2(1+1)**

Objectives

- To provide knowledge about Self-pollinated and cross pollinated Rabi crops.
- To learn about origin and distribution of Rabi crops.
- To design breeding objectives of major Rabi crops.
- To impart information on different crop varieties for Rabi season.

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Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in Wheat, Oat, Chickpea, Rapeseed & Mustard etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species viz. Wheat, Oat, Rapeseed & Mustard, Pulses, Potato, Sugarcane, Tomato, Chilli, Onion etc. Study of field techniques for seed production and hybrid seed production in rabi crops; Estimation of heterosis, inbreeding depression and heritability; Study of quality characters, donor parents for different

characters in tomato; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

Suggested readings

- Breeding field crops-I by V.L. Chopra.
- Genetic improvement of field crops by C.B. Singh and D. Khare.
- Genetics and Breeding of Pulse crops by D.P. Singh.
- Vegetable breeding – Principles and Practices by Hari Har Ram.
- Breeding field crops by D.A. Sleper and J.M.Poehlman.
- Plant Breeding –theory and practice by S.K. Gupta.
- Breeding Asian field crops by J.M. Poehlman and D.N. Barthakur.
- Practical manuals on Crop Improvement I (Rabi crops) by Rajendra Kumar Yadav.

ACSS 306: **Agricultural Microbiology and Phyto-remediation 2(1+1)**

Objectives

- To get an introduction to microbiology with specific focus on its significance in agriculture science.
- To get acquainted with the bacterial structure and the function of the different bacterial components.
- To get highlights on different fields of microbiology.
- To get highlights on the bioremediation of polluted soils using microbial mediators and phytoremediation.

Theory

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

Practical

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

Suggested readings

- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2002. Microbiology. 5th Edition, Tata McGraw-Hill,New Delhi.
- Rangaswami, G. and Bagyaraj, D. J. 2005. Agricultural Microbiology. Prentice-Hall of IndiaPvt. Ltd., New Delhi.
- Mukherjee, N. and Ghosh, T. 2004. Agricultural Microbiology. Kalyani Publishers, Calcutta.
- Dubey, H.C. 2007. A Textbook of Fungi, Bacteria and Viruses. Vikas Publishing House Ltd.,New Delhi – 10014.
- Salyers, A. A. and Whitt, D. D. 2001. Microbiology: diversity, disease, and the environment.Fitzgerald Science Press, Inc.
- Prescott, L. M. 2002. Microbiology 5th Edition. McGraw-Hill Inc, US.
- Alexander M. 1985. Introduction to Soil Microbiology 2nd ed. John Wiley and Sons, Inc., New York.

ABC 307: **Essentials of Plant Biochemistry 3 (2+1)**

Objective

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

Theory

Biochemistry: Introduction and importance, Properties of water, pH and buffer, plant cell andits components.
Bio-molecules: Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids.
Enzymes: general properties and classification; mechanism of action; factors affecting enzymatic reaction, Michaelis-Menten and Lineweaver - Burk equation & plots, regulation of enzyme activity; introduction to allosteric enzymes, Vitamins – physiological and metabolic role.
Metabolic energy and its generation: Metabolism – Basic concepts.
Catabolism of Carbohydrate: Glycolysis, Pentose phosphate pathway, TCA cycle, glyoxylate cycle, electron transport chain and oxidative phosphorylation.
Fatty acid and Amino acid catabolism: Degradative pathway and Regulation of metabolic pathways.

Practical

Preparation of standard solutions and reagents, Determination of pH, Qualitative tests ofcarbohydrates and amino acids, Quantitative estimation of soluble sugars and reducing sugar, Estimation of soluble protein by Lowry's method, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Enzyme assay.

Suggested reading

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

- Biochemistry by Donald Voet and Judith G. Voet. Fourth Edition. Wiley (Can be downloaded).

SWC 308: Introductory Agro forestry 2 (1+1)

Objectives

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

Theory

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

Practical

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

Suggested readings

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

Hort (A) 309: Ornamental Crops, MAPs and Landscaping 2(1+1)

Objectives

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

Theory

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

Practical

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

Suggested readings

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

SEMESTER VI

AGR 351: Dryland agriculture/ Rainfed agriculture and watershed management 2(1+1)

Objectives

- To learn about characteristics and conditions of dryland/rainfed agriculture
- To gain knowledge about drought and its mitigation
- To impart knowledge on water harvesting and watershed management

Theory

Dryland/Rainfed agriculture: Introduction, types and characteristics; History of dry land/rainfedagricu in India; Problems and prospects of dry land/rainfed agriculture in India ; Soil and climatic conditions prevale dry land/rainfed areas; Soil and water conservation techniques, **Drought**: types, effect of water deficit on ph morphological characteristics of the plants, Crop adaptation and mitigation to drought; **Water harvesting**: import its techniques, Efficient utilization of water through soil and crop management practices, Crops and cropping sys in dry land/rainfed areas; Management of crops in dry land/rainfed areas, Contingent crop planning for abe weather conditions, Concept, history, objective, principles and components of watershed management, fa affecting watershed management.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and onset and withdrawal of monsoons. Studies on cropping pattern of different rainfed areas in the country, demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplementary irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought in the country. Effective rainfall and its calculation. Studies on cultural practices for mitigating moisture including mechanical and agronomic measure. Soil moisture determination under different land situations, Importance of seed priming to mitigate drought. Assessment of meteorological drought. Characterization and delineation of watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction water harvesting structures. Visit to rainfed research station/watershed**.**

Suggested readings

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

AMP 352: Introduction to Agro-meteorology 2(1+1)

Objectives

- To introduce the students to the concept of weather and climate and underlying physicalprocesses occurring in relation to plant and atmosphere.
- To impart the theoretical and practical knowledge of instruments/equipment used formeasurement of different weather variables in an agrometeorological observatory.
- To study the meteorological aspects of climate change in agriculture and allied activities.

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere: its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Application of Thermal time concept and Crop/ Pest weather calendar; Energy balance of earth; Atmospheric humidity, concept of saturation, vapour pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture; Weather hazards - drought, floods, frost, tropical cyclones and extremeweather conditions such as heat-wave and cold-wave; Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording, 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. Determination of vapor pressure and relative humidity, Determination of dew point temperature, Measurement of atmospheric pressure. Measurement of wind speed and wind direction, preparation of windrose, Measurement, tabulation and analysis of rainfall. Measurement of open pan evaporation. Crop weather calendar.

Suggested Readings

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

GPB 353: Crop Improvement (*kharif* crops) I 2(1+1)

Objectives

- To provide knowledge about Self-pollinated and cross pollinated Kharif crops.
- To learn about origin and distribution of Kharif crops.
- To design breeding objectives of major Kharif crops.
- To impart information on different crop varieties for Kharif seaso.

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in Maize, Rice, Sorghum, Pearl Millet and Pigeopea etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species viz. Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeopea, Urdbean, Mungbean, Soybean, Groundnut, Sesame, Castor, Cotton, Cowpea, Tabacco, Brinjal, Okra and Cucurbitaceous crops. Maintenance breeding of different kharif crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seed production in kharif crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of qualitycharacters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

Suggested readings

- Breeding field crops-I by V.L. Chopra.
- Genetic improvement of field crops by C.B. Singh and D. Khare.
- Genetics and Breeding of Pulse crops by D.P. Singh.
- Vegetable breeding – Principles and Practices by Hari Har Ram.
- Breeding field crops by D.A. SleperandJ.M.Poehlman.
- Plant Breeding –theory and practice by S.K. Gupta.
- Breeding Asian field crops by J.M. Poehlman and D.N. Barthakur.
- Practical manuals on Crop Improvement I (Kharif crops) by Rajendra Kumar Yadav.

ABT 354: Fundamentals of Agricultural Biotechnology 3(2+1)

Objectives

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

Theory

Introduction to Plant Tissue Culture: History of Plant Tissue Culture; Cellular totipotency and cyto-differentiation; Callus culture, Single-cell/suspension culture and their applications; Organogenesis and somatic embryogenesis; Somaclonal variation and its use incrop improvement; Embryo rescue technique and its significance in hybrid development; *Invitro* fertilization, ovule culture and its significance in hybrid development; Protoplast isolation, culture and regeneration; Somatic hybridization (somatic hybrids and cybrids) and its application in crop improvement; Anther and pollen culture for haploid production; Development ofdisease-free (virus free) plants through apical meristem culture; Micropropagation techniquefor the generation of quality planting material; Synthetic seeds and its applications; National certification and Quality management of TC plants, secondary metabolite production, *In vitro* germplasm conservation.

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

Introduction to Recombinant DNA Technology: DNA modifying enzymes and vectors; Plant genetic transformation – physical (Gene gun method), chemical (PEG mediated) and Agrobacterium-mediated gene transfer methods; Transgenic and its importance in crop improvement with successful stories; biosafety.

Introduction to Various Molecular Markers: Concepts of DNA markers, Types of DNA markers, RFLP, RAPD, SSR, SNP etc.; Marker-assisted breeding in crop improvement.

Practical

Introduction to Plant Tissue Culture Laboratory; Good Laboratory Practices; Media Preparation and sterilization; Glassware sterilization; Micropropagation; Callus induction andculture; Anther culture; Apical meristem culture; Preparation of synthetic seeds; Isolation of plant genomic DNA; Isolation of Plasmid DNA Quantification of DNA; PCR amplification of DNA, Agarose Gel Electrophoresis and visualization of DNA; Restriction digestion of plasmid DNA; Visit to tissue culture units/biotech labs.

Suggested Readings

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

AST 355: Basic and Applied Agricultural Statistics 3(2+1)

Objectives

- To provide an idea on statistical concepts of both descriptive and inference Statisticswhich will be useful to do statistical analysis.

Theory

Introduction to Statistics and its Applications in Agriculture. Types of Data. Scales of measurements of Data. Summarization of Data. Classification of Data. Frequency Distribution. Methods of Classification. Definition of Grouped and Ungrouped Data. Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), MidPoints. Types of Frequency Distribution. Diagrammatic Presentation of Data. Bar Diagrams –Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram. Graphical Presentationof Data – Histogram, Frequency Polygon and Ogives.Measures of Central Tendency. Requisites for an Ideal Measure of Central Tendency. DifferentTypes of Measure. Arithmetic Mean– Definition, Properties, Merits, Demerits and Uses. A.M. (examples) for Grouped and Ungrouped Data. Step-deviation Method. Weighted Mean. Definition of Geometric Mean and Harmonic Mean. Relationship between A.M., G.M. and H.M. Median-Definition, Merits, Demerits and Uses. Graphical Location of Median. Mode- Definition, Merits, Demerits and Uses. Graphical Location of Mode. Relationship between Mean, Median and Mode. Measures of Dispersion. Characteristics for an Ideal Measure of Dispersion. Different Types of Measures of Dispersions. Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation. Standard Deviation- Definition, Properties. S.D. and Variance for Grouped and Ungrouped Data. Variance of Combined Series. Co-efficients of Dispersions. Co-efficient of Variation.Measures of Skewness and Kurtosis. Definition of Symmetrical Distribution. Definition ofSkewness, Measures of Skewness. Definition of Kurtosis. Measure of Kurtosis. Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution. Probability Theory and Normal Distribution. Introduction to Probability. Basic Terminologies. Classical Probability-Definition and Limitations. Empirical Probability- Definition and Limitations. Axiomatic Probability. Addition and Multiplication Theorem (without proof). Conditional Probability. Independent Events. Simple Problems based on Probability. Definition of Random Variable. Discrete and Continuous Random Variable. Normal Distribution- Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve. Correlation and Regression. Definition of Correlation. Scatter Diagram. Karl Pearson's Coefficient of Correlation.Types of Correlation Coefficient. Properties of Correlation Coefficient. Definition of

Linear Regression. Regression Equations. Regression Coefficients. Properties of Regression Coefficients.Tests of Significance. Definition. Null and Alternative Hypothesis. Type I and Type II Error. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample, Two Sample and Paired t-test with Examples. F-test for Variance. ANOVA and Experimental Designs. Definition of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD). Sampling Theory. Introduction. Definition of Population, Sample, Parameter and Statistic. Sampling Vs Complete Enumeration. Sampling Methods. Simple Random Sampling with Replacement and without Replacement. Use of Random Number Table.

Practical

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

Suggested readings

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

PPH 356: Fundamentals of Crop Physiology 3(2+1)

Objectives

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

Theory

Introduction: Importance of physiology in various fields of agriculture. **Plant-water relations**: Structure of water, functions and properties of water. Importance of water for plant growth and development. Water movement in plants, concept of diffusion, osmosis and imbibition. **Concept of water potential**: Definition, components of water potential in plant cell and soils. Water in soil; forms of water in soil and available water. Concepts of water saturation, field capacity, wilting point.Water absorption. Symplastic and apoplastic movement of water in plants. Internal and external factors influencing water absorption in plants. **Translocation of water**: Theories explaining ascent of sap (water translocation). Soil-plant-atmosphere continuum; Internal and external factors influencing water translocation in plants. **Transpiration**: Definition, types of transpirations in plants, significance of transpiration; Transpiration in relation to crop productivity. Transpiration ratio. **Stomatal physiology**: Structure of Stomata, types and stomatal movement. Theories explaining the stomatal movement. Factors affecting transpiration rate. Concept of cavitation. Water use efficiency and its relevance. Water use efficiency in C3, C4 and CAM plants. Anti-transpirants- Definition, different types of Anti-transpirants with examples. **Mineral Nutrition**: Definition, importance of plant nutrients, Arnon's criteria of essentiality. Classification of essential nutrients based on requirements, Physiological role and Biochemical functions and based on mobility in phloem. **Mechanisms of ion uptake**: Theories explaining ion

uptake, Passive and active ion uptake, membrane transporters and carriers. **Photosynthesis**: definition, structure of chloroplast and its function. Photochemical and biochemical reactions and their importance for photosynthesis. Mechanism of carbon fixation in C3, C4 and CAM plants. **Steps in carbon fixation**: Chemo-osmotic theory and ATP production. Kranz leaf anatomy in C4 plants and its relevance. Difference between C3, C4 and CAM pathways. Internal and external factors influencing photosynthesis in plants. Phloem loading and unloading; difference between apoplastic and symplastic phloem loading. Photorespiration; significance and steps involved in photorespiration. **Respiration**: definition and significance of respiration, structure of mitochondria and its function. Respiratory substrates and Respiratory quotient, types of respiration, Steps in aerobic respiration. Anaerobic respiration/ fermentation. Alternative respiration /pentose phosphate pathway. Cyanide resistance respiration in plants. Internal and external factors influencing rate of respiration in plants. Relationship between respiration, photosynthesis and yield. **Plant growth and development**: Definition. Plant growth pattern and growth curve. Determinate and indeterminate growth habits. Monocarpic and polycarpic species with examples. Growth and yield parameters and their measurements; Measurement and Formulae used for determining Leaf Area Index (LAI), Leaf area duration (LAD), Specific leaf area (SLA), Crop Growth rate (CGR), Net assimilation rate (NAR), Relative growth rate (RGR), Harvest Index (HI). **Plant growth regulators and Hormones**: Endogenous and exogenous (synthetic) growth regulating substances. Discovery and site of synthesis of different plant hormones. Synthetic growth regulating substances, growth retardants, growth inhibitors, pinching agents, male sterility. Importance of plant growth regulators in modulating crop growth. Physiological importance of different plant hormones such as Auxin, Gibberellin, Brassinosteroid, cytokinin, ABA, ethylene etc., Biosynthesis and mode of action of plant hormones, applications of plant growth regulators in agriculture, horticulture and industry. **Stress Physiology**: Acclimation and adaptation mechanisms. Plants response to stress. Strategies adopted by plants to overcome stress effects. Drought tolerance traits and their relevance.

Practical

Preparation of standard solutions, units of concentration and dilution; Methods of measuring water status in plant tissue; Determination of stomatal frequency and index; Measurement of stomatal conductance and transpiration; Extraction, separation and quantification of photosynthetic pigments; Measurement of water use efficiency at single leaf level; Measurement of photosynthetic rate; Measurement of respiration rate; Measurement of growth and yield parameters; Deficiency symptoms of nutrients and their identification; Growth hormone bioassay Effect of moisture stress on seed germination and seedling vigour.

Suggested readings

- Advanced Plant Physiology – Malcolm B. Wilkins.
- Introduction to Plant Physiology – William G. Hopkins.
- Introductory Plant Physiology- RayNoggle G. and Fritz G. J.
- Plant Physiology – Robert, M. Devlin and Francis H. Witham.
- Plant Physiology (3rd edition) - Taiz L. and Zeiger E.
- Plant Physiology (4th Indian Edition) - Frank, B. Salisbury and Cleon W. Ross.

AEC 357: Agricultural Finance and Cooperation 2(1+1)

Objectives

- To impart knowledge on issues related to priority sector credit management and financial risk management.

Theory

Agricultural finance meaning scope and significance, credit needs and its role in Indian agriculture. Agricultural credit meaning definition need classification credit analysis 3R's and 5C's of credits sources of agricultural finance institutional and non-institutional Sources, commercial banks, social control and nationalization of commercial banks. Micro financing including KCC. Lead bank scheme RRBs, Scale of finance and unit cost Anintroduction to higher financing institution – RBI, NABARD, ADB, IMF World Bank, insurance and credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements –Balance Sheet and income statement. Basic guidelines for preparation of project reports. Bank norms – SWOT analysis. Agricultural Cooperation – Meaning, brief history of cooperative development in India, objective, principles of co-operation, Significance of cooperatives in Indian Agriculture. Agricultural cooperation in India – credit, marketing, consumer and multi–purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farmingcooperatives, cooperative warehousing role of ICA, NCUI, NCDC, NAFED, 3R's, 5C's, and 7P's of credit. Crop insurance: its scope, significance and limitations and the potential of the newly launched Pradhan Mantri Fasal Bima Yojana (Prime Minister's Crop Insurance Scheme). Successful cooperative systems in Gujarat (AMUL) Tamil Nadu (Aavin), Karnataka (Nandini), Maharashtra and Punjab.

Practical

Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire first-hand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business- A case study preparation and analysis of balance sheet – A case study preparation and analysis of income statement – A case study. Appraisal of a loan proposal – A case study. Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value-added products. Seminar on selected topics. Different types of repayment plans.

Suggested readings

- Gittinger, J.P. 1982. Economic Analysis of Agricultural projects, The johns Hopkins Univ. press.
- Ready S. S. and Ram, P. R.1996, Agricultural Finance and Management. Oxford & IBH.

SST 358: Fundamentals of Seed Science and Technology 2 (1 + 1)

Objectives

- To developthe knowledge inSeed Science and Technology

Theory

Introduction to Seed Technology; Deterioration and Maintenance of varietal purity; Foundation and Certified seed production of cereal crops; Foundation and Certified seed production of Oilseed crops; Foundation and Certified seed production of Pulses crops; Seed Drying; Seed Treatment; Seed storage; Seed certification; Seed Legislation; Basics of seed quality testing; Seed quality enhancement.

Practical

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

Suggested Readings

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

AEG 359: Renewable energy in Agriculture and Allied Sector 2 (1+1)

Objectives

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

Theory

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

Practical

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

Suggested readings

- C.S. Solanki. 2011. Solar Photovoltaic – Fundamentals, Technologies and Applications. PHILearning Pvt. Ltd.
- S. Sukhatme and J. Nayak. 2008. Solar Energy: Principles of Thermal Collection and Storage.Third Edition (Tata McGraw-Hill).
- V.V.N. Kishore. 2008. Renewable Energy Engineering and Technology: Principles and Practice,Teri, India.

EC 401: Hill, Dry land and Coastal Agriculture: Scenario in West Bengal 4(3+1)
Offering Department: AGR

Theory

Concept of hill agriculture, distribution in West Bengal, soil and climate, terrace cultivation, jhum cultivation, traditional farming, cropping system, agronomic management including irrigation, soil and water conservation methods; Concept of dry land agriculture, distribution in West Bengal, soil and climate, moisture stress and drought, cropping system, agronomic management including choice of crops/varieties moisture conservation, irrigation scheduling, use of indicator plantsand anti-transpirants; drought avoidance/ mitigation practices, contingent crop planning; concept of coastal agriculture, distribution in West Bengal, soil and tidal water management, cropping system, agronomic management including choice of crops/varieties, irrigation and drainage; rice cum fish culture, shelter belts.

Practical

Sowing and management of rainferabi crops including use of mulches and anti-transpirants; calculation on drought indices and water use efficiency; making contour bunds against slopes; calculation on scheduling of irrigation of different crops; Determination of quality of irrigation water; preparation of contingent crop planning schedule for early, mid-season and terminal droughts in dry land areas and storm affected areas of coastal region; Visit to local rice cum fish culture farm.

EC402: Principles and Practices of Organic Farming and Conservation Agriculture 4(3+1)
Offering Department: AGR

Objectives

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

Theory

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

Practical

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

botanicals for insect-pest management; Weed management in organic farming; Cost of organic production system; Practices of conservation agriculture.

EC403: Issues and Advances in Weed Management 4 (3+1)
Offering Department: AGR

Theory

Classification, characteristics ,reproduction and dissemination of weeds; crop – weed association /competition and weed seed bank; Harmful and beneficial effects of weeds and their utilization; Survey and surveillance of weeds including invasive ones; Eco-safe weed management by cultural and mechanical methods; Biological methods, bioagents, bio-herbicides and allelopathy in weed management; status, avantages and limitations of usage of herbicides in India; Chemical weed management, herbicides: Classification, selectivity, resistance, mixtures, compatibility with other agro-chemicals, Concept of formulations and use of adjuvents, safeners and surfactants; Concept and application of integrated weed management for major field crops; Weed management for important cropping systems.

Practical

Identification of weed flora in various ecological situations and cropping systems; Study on crop-weed competition and weed seed bank; Techniques of weed preservation and preparation of weed herbarium; Study on bio-efficacy and phytotoxicity symptoms of herbicides in different crops; Computation of herbicide doses and demonstration of application methods; Calculation on weed index and weed control efficiency; Preparation and application of bio-herbicides; Weed utilization as compost (Parthenium, Water hyacinth, Cassia etc.).

EC 404: Watershed and Wetland Management 4(3+1)
Offering Department: SWC+AGR+ASC

Theory

Delineation of watershed; Watershed Atlas of India; Selection criteria and methods of identification of watershed; Steps, procedure and planning of watershed management; Watershed hydrology, rainfall-runoff relationship; Case studies of some identified watershed and their management under different agro-climatic situation; Selection of different conservation treatment and production systems and their use in watershed management; Developing economically and ecologically sustainable agro-forestry systems for watershed; and restoration and challenges; Livelihood development and impacts of agriculture on wetlands. Definition, types, classification, values, attributes, functions, ecosystem services, impact of climate change on wetland ecosystems. Developing an integrated wetland management plan, key principles of managing wetlands, setting up a management planning process, a step-wise method for developing an integrated management plan, steps for implementing the management plan, managing wetlands under a changing climate, wise-use of wetlands and conservation, suitability and fitness assessment of wetlands for fisheries. Definition of fisheries, types of fisheries, definition of aquaculture, types of aquaculture, aquaculture systems, aquaculture methods, culturable fish species, aquaculture practices: composite fish culture, brackish water fish culture, concept, principle, advantages and types of integrated fish farming, rice-fish, duck-fish, poultry-fish and cattle-fish integrated farming practices.

Practical

Study on watershed atlas of India; Delineation of watershed; Rainfall analysis–frequency, intensity, duration and probability; Analysis of rainfall-runoff relationship; Case studies of a few identified watersheds – their management under different agro-climatic situations; Wetland

morphometry, Analysis and identification of abiotic (physico-chemical properties of water) and biotic components (aquatic plants, phytoplankton, zooplankton and benthic invertebrates) of wetlands; Study on different types of livestock production systems in wetlands; Identification of some culturable fish and prawn species; Determination of water quality parameters (Transparency, pH, DO, COD/BOD) and biological parameters (primary productivity, zooplankton abundance).Visit different types of models for aquatic crops and integrated fish farming in wetland.

EC 405: Production and Use of Biofertilizers 4(3+1)
Offering Department: ACSS

Objective

- To provide knowledge on principles, methods, and mechanism of biofertilizers and their usein agriculture

Theory

Introduction, status and scope of biofertilizers. 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 ectomycorhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation, mechanism of nitrogen fixation. Mechanism of phosphate solubilization and mobilization, K mobilization. Production technology: Acquaintance with the Development of biofertilizer production unit. Types of culture media, strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers - Storage, shelf life and marketing. Factors influencing the efficacy of biofertilizers.

Practical

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

Suggested readings

- Borkar, S.G. 2015. Beneficial Microbes as Biofertilizers and its Production Technology.
- Nehra, Sampat. Biofertilizers for Sustainable Agriculture. Aavishkar Publishers, Jaipur, India.
- Singh, Awani Kr. Handbook of Microbial Biofertilizers. Agrotech Press, Jaipur, India.
- Trivedi, P.C. Fungal Biopesticides and VAM applications. Pointer Publishers, Jaipur, India.

EC 406: Agriculture Waste Management 4 (3+1)
Offering Department: ACSS

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, Micribiology and Biochemistry of composting. Quality improvement of compost prepared from agricultural waste and product development. 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 form dairy parlors, agro-waste recycling through farming system, waste management machineries, environmental benefit of waste management.

Practical

Collection and preparation agricultural waste sample. Determination of pH, EC, CEC, heavy metals, BOD, COD, TSS, TDS, NH_4, Total P, and dissolved reactive P. Nutrient status (N, P, K, secondary and micronutrients) analysis of agricultural waste. The CO_2 emission during composting, C-build up on application of compost in soil, enumeration of lingo-cellulolytic microorganisms from compost. 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.

Suggested readings

- Agriculture and Waste Management for Sustainable future - by Sannigrahi A. K. New India Publishing agency.
- Agriculture Waste Management and Bioresource - by Singh. S. et. Al. Wiley publishers
- Composting; Sanitary disposal and reclamation of organic waste - by Gotaas H. B. WHO
- Management of Natural Resource for Sustainable Development - by Vijay Singh Rathor and B. S. Rathor, Daya Publishing House.

EC 407: Deficiency and Toxicity of Elements in Soil, Plant, Water 4 (3+1)
Offering Department: ACSS

Theory

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

Practical

Collection and preparation of soil samples. Estimation of pH, EC, Organic C, available N, P, K, S, Ca and Mg, Na and micronutrient and heavy metals viz. Pb, Cd, Ni etc. Plant sampling and sample preparation for analysis. Estimation of total C, N, P, K, S and micronutrient content in plant.

Suggested readings

- Introductory Soil Science – by Dilip Kumar Das, Kalyani Publishers.
- Textbook of Soil Science – by S. K Pal. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
- Soil Fertility and Fertilizers – by Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York.

EC 408: Non-insect Pests of Crops and Their Managements 4 (3+1)
Offering Department: AEN

Theory

History, definition and economic importance of plant parasitic nematodes, phytophagous mites, rodents, agriculturally important birds, snails and slugs. General characters of aforementioned organisms, their morphology, taxonomy, classification, biology and behavior symptomatology and management.

Practical

Morphological study and identification of agriculturally important mites, nematodes, rodents, birds, snails and slugs etc. Collection, cleaning and preservation as far as possible. Studies of symptoms of damage and habitat study. Sampling and estimation of population.

EC 409: Bio-control Agents and Bio-pesticides in insect-pest Management 4 (3+1)
Offering Department: AEN

Theory

Balance of nature-natural control. Biological control-defination, its advantages and disadvantages Biocontrol agents, arachnids, fungi, bacteria, viruses, protozoa, Vertebrates. Brief history of bio-control with examples of successful cases. Insects parasitoids and predators-types of parasitism. Methods of biological control- conservation, augmentation and importation. Predators and parasitoids of agricultural importance- Coleoptera (Coccinellids, Carabids, Staphylinids): Hemiptra (Mirids, Redduviids, Pentatomids): Diptra (Syrphids, Tachinids): Lepidoptra (Pyralid- Epiricania melanolenca): Hymenoptra (Trichogranmatids, Eulophids, Scelionids, Mymarids, Braconids, Ichneumonids): Spiders (Arachina); Mites (Phytoseiids) and Weed feeding herbivores-Zygogramma bicolorala. Bio-pesticides – Entomopathogenic microbes, Bacteria – *Bascillus thuringensis, B papillae; Fungi* – (*Beauveria bassiana, Metarhizium anisopliae, Verticilium lecanii, Nomuraea rileyi,* Viruses (NPV and GV); Nematodes (Heterohabidity idea, Steinemematidae and Protozoa. Mass production of bio agents).

Practical

Mass rearing of natural enemies- facilities required in general for mass production of natural enemies. Mass rearing of host insects of natural enemies on nature or artificial diets – a) *Corcyra cephalonica,* b) *Spodoptera litura,* c) *Plutella xylostella* d) *Helicoverpa armigera,* e) Mealy bugs, f) *Galleria mellonella.* Mass production of parasitoids and predators – a) *Trichogramma chilonis / T. japonicum,* b) *Bracon brevicornis* c) *Cotesia plutellae,* d) *Chrysoperla carnea* e) *Cryptolaemus montrouzieri,* f) *Scymnus coccivora.* Mass production of weed feeding herbivore- *Zygogranma bicolorata*. Quality control of natural enemies. Impact assessment of natural enemies.

EC 410: Insect Ecology & IPM 4 (3+1)
Offering Department: AEN

Theory

Insect Ecology: Definition, relation and differences between Ecology, Ecosystem and Environment. Environment and its components. Ecosystem approach to Ecology- Component and subdivisions, Major Processes in Ecosystem. Biological organisation of the ecosystem and ecological succession. Effect of abiotic factors–temperature (emphasizing on role of heat energy in all biological activities of organisms), moisture, humidity, rainfall, light, atmospheric pressure and air currents. Food chain and food web, trophic levels and trophic structures.
Biotic factors- Food as a limiting factor for distribution and abundance, biotic potential, environmental resistance and carrying capacity. Concepts of balance and dynamism of life in nature. Concept of fitness and natural selection. Biodiversity- its fragility and maturity with special reference to agro-ecosystem.

IPM: Definition and evolution of various related terminologies in IPM, Concept and philosophy of IPM - IPM-IPC debate. Factors supporting IPM decisions- Agro-Ecosystem Analysis (AESA) - Economic threshold concept and economic consideration - pest risk analysis - pest surveillance and pest forecasting; Categories of pests; Components of IPM: Host plant resistance - Cultural, Mechanical, Physical, Legislative (Qurantine), Biological (parasites, predators & transgenic plant pathogens such as bacteria, fungi and viruses) methods of control and Chemical control (importance, hazards and limitations, classification of insecticides, toxicity of insecticides and formulations of insecticides, MRL). Modern methods of pest control: repellents, antifeedants, semiochemicals, attractants, gamma radiation and genetic control. Scope and limitations of IPM in developing countries.

Practical

Study of distribution pattern of insects in crop ecosystem. Sampling techniques for the estimation of insect population and damage. Habit, habitat, distribution, sampling and identification of mite pests. Survey on pest s and forecasting of pest incidence. Pest surveillance through light trap, pheromone traps and forecasting of pest incidence. Identification of pests and their estimation. Identification of bio-control agents and their qualitative and quantitative estimation. Label and toxicity of insecticides. Acquaintance of insecticides formulations. Calculation of doses/concentration of different insecticides. Plant protection equipments and spray droplet size Compatibility of pesticides with other agro-chemicals and phytotoxicity of insecticides. Study of insect pollinators, weed killers and scavengers. Commonly used acaricides, rodenticides and nematicides. Microbial insecticides and IGRs. Application of IPM techniques, integration and case studies.

EC 411: Commercial Entomology 4 (3+1)
Offering Department: AEN

Theory

Importance of beneficial Insects, Beekeeping and pollinators, bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee. Role of pollinators in cross pollinated plants. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection. Species of lac insect,

morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac- products. Important species of pollinator, weed killers and scavengers with their importance.

Practical

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

EC 412: Principles and methods of plant disease management 4 (3+1)
Offering Department: PPA

Theory

Principles of plant disease management - avoidance, exclusion, eradication, protection, host resistance and therapy. Methods of plant disease management under each principle. Methods and implementation of IDM following cultural, mechanical, physical, legislative, biological, organic amendments, botanicals and chemical control of plant diseases.

Chemicals used in plant disease control - fungicides, bactericides, nematicides and antiviral chemicals. History and development of chemicals, advantages and disadvantages of chemicals.

Chemical nature, characteristics and classification of fungicides mentioning major groups of non-systemic and systemic fungicides. Formulation of different fungicides-types, uses, advantages, adjuvant, stickers and spreaders. Mode of action, compatibility and application of different fungicides and phytotoxicity of fungicides.Chemical nature, characteristics and mode of action and application of different antibiotics. Antibiotics resistance in plant pathogens. New chemical molecules in plant disease management. Bio-fungicides including botanicals: types, mode of actions, application, formulation and shelf life - quality issues, problems and prospects. General account of plant protection appliances. Development of fungicidal resistance.

Practical

Acquaintance with formulation of different fungicides and plant protection appliances. Studies on fungicides application equipment-types of sprayers, dusters and nozzles. In vitro evaluation of fungicides and bacteriocides following poisoned food technique. Preparation of different concentrations of chemicals based on active ingredients against pathogens; Minimum inhibitory concentration (MIC) of different antibiotics against plant pathogenic bacteria. Isolation of biocontrol agents, extraction of bioactive plant extracts, testing, mass production and formulation.

EC 413: Essentials of Plant Pathology 4 (3+1)
Offering Department: PPA

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology including signs and symptoms, disease and disorders, disease triangle and disease pyramid. Cause and classification of plant diseases. Types of symptoms caused by fungi, bacteria, viruses and abiotic agents and their role in disease diagnosis. Pathogenesis, phenomenon of infection - pre penetration, penetration and post penetration. Colonization of plant pathogens. Early detection of plant pathogens based on serological and nucleo-based techniques. Role of enzymes, toxin, growth regulators and polysaccharides in pathogenesis: Different avenues for the entry of

pathogens. Survival and dissemination of pathogens. Defense mechanism in plants – structural and biochemical (pre and post infection), Plant disease epidemiology. Plant disease forecasting, remote sensing. Application of Biotechnology in plant disease management- development of disease resistant transgenic plants through gene cloning. Different techniques used for isolation, purification and inoculation of fungi and bacteria. Techniques for staining and preservation of micro-organisms

Practical

Pure culture techniques and use of selective media to isolate pathogens. Isolation, inoculation and purification of plant pathogens and proving Koch's postulates. Studies on survival structures of pathogens, symptoms of the diseases and preservation of plant pathogens and disease specimens, colonization of pathogens on or in hosts – ectophytic, endophytic, sub-cuticular, parenchyma, vascular tissue and systemic colonization, procedure for assessment of the disease. Use of haemocytometer, micrometer, camera lucida for micrometric studies of fungal pathogens.

EC 414: Commercial Plant Breeding 4 (3+1)
Offering Department: GPB

Objectives

- To discuss about hybrid development and various crop improvement aspects of fieldcrops viz., rice, wheat, maize, pearl millet, sorghum, pigeonpea, chickpea, green gram, blackgram, lentil, soybean, groundnut, rapeseed-mustard, cotton etc.
- To provide understanding on tissue culture and biotechnological approaches asalternative strategies for development of line and cultivars.
- To impart knowledge on seed production, release and notification of varieties and PPV&FR Act, 2001.

Theory

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

Practical

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

Suggested readings

- Commercial Plant Breeding at a glance by Phundan Singh, PratibhaBisen, Reshu Tiwari. Daya Publishing House.
- Plant Breeding: Principles and Methods by B. D. Singh. Kalyani Publishers.
- Principles of Plant Breeding (1st & 2nd Edition)" by RW Allard.
- Breeding Field Crops by JM Poehlman.
- Commercial Plant Breeding Objective: Phundan Singh, Mridula Billore and Monika Singh, 2021, Astral Publishing, 160p.
- Breeding and Crop Production: H. Padmalatha, Random.
- Biotechnology for Agricultural Breeding: Mangal, S K, GeneTech Books.

EC 415: Weather Services, Crop weather modeling & Climate change in Agriculture 4(3+1)
Offering Department: AMP

Theory

Weather forecasting system: definition, scope and importance, forecasting problems: classified terminology of weather parameters used in weather forecasts and their interpretation; elements of agricultural weather forecasts; types of forecasting: short, medium and long-range, study of synoptic charts with special reference to location of highs and lows. thunderstorm prediction: interpretation of satellite pictures of clouds in visible and infrared range. Weather-based advisories: concept of agrometeorological advisory; preparation of weather-based advisories for farmers and dissemination: verification of weather forecasts. Special forecasts: special forecasts for natural calamities such as drought, floods, high winds, cold (frost) and heat waves, hail storms, cyclones and protection measures against such hazards; Concept of Production Levels for crop modeling. General features of dynamic simulation models; Evaluation of dynamic simulation models—verification, calibration and validation. Brief features of dynamic simulation models—CERES, Oryza and Info Crop. Application of crop models. Use of crop simulation model in determining climate change impact on agriculture. Factors of crop production; Weather elements and crop production; Introduction to crop modeling. Types crop of models based on nature and characteristic—empirical and mechanistic; static and dynamic; deterministic and stochastic with examples. Types of crop model based on application; Statistical Crop Models—general features of statistical crop modeling techniques. Regression Models incorporating weather, soil, plant and remote sensing inputs. Evaluation of regression models; Use of regression technique for crop-weather yield modeling. Yield prediction models. Global warming. Climate variability and climate change. Causes of climate change. Historical rainfall and temperature change in the observed and simulated data. GCM and RCM based future climate scenarios. Impact of climate change on water resources and major agricultural crops. Adaptation and mitigation measures for climate change in Indian Agriculture.

Practical

Preparation of weather-based agro-advisories based on weather forecast. Preparation of crop weather calendar for principal crops. Verification of medium range weather forecasts and analysis of feedback from farmers receiving AAS bulletins.Working with statistical models. To develop linear regression models involving weather data and yield of principal crops. To develop nonlinear regression models involving weather data and yield ofprincipal crops. Quantifying local scale climate variability and change by analyzing station and GCMs data (Mean, SD, CV etc.). Assessment of past and future temporal trend (parametric and non-parametric) of rainfall and temperature. Analysis of extreme weather events based on daily/monthly rainfall and temperature data.

EC 416: Agricultural Journalism 4 (3+1)
Offering Department: AEX

Objectives

- To impart knowledge and skill in agricultural journalism

Theory

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

Practical

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

Suggested Readings

- Sagar Mondal and Das S, 2016. Agricultural Extension and Rural Journalism, Kalyani Publishers, Ludhiana.
- Basic Journalism by Rangaswami Parthasarathy.
- News Reporting and Editing by K. M. Shrivastava.
- Professional Journalism by M.V. Kamath.
- The Journalist's Handbook Book by M.V. Kamath.
- Farm Journalism and Media Management – Bhaskaran et al.
- Agricultural Extension and farm Journalism – A K Singh.
- Farm Journalism – Jana and Mitra.

417: Strategies and approaches of Agricultural Extension 4 (3+1)
Offering Department: AEX

Objectives

- To orient the students regarding extension systems of different countries.
- To give an idea regarding functioning of KVK.

Theory

World History of Agricultural Extension; History of Extension Education in India; Generation of extension in developing countries; colonial agriculture, Broad based Extension, Area specific target group extension, the first Green Revolution, top down extension, e-extension & e-agriculture, transfer of technology project of ICAR, models of transfer of technology, transfer of technology models developed by IARI, Agricultural extension in Japan, Philippines, Bangladesh, USA, UK, ICT; concept, definition , networking system of information- LAN, PAN , WAN, MAN, WIKI And Blog, Virtual Reality, Digital divide, Social network, KVK: concept, objectives, mandate, manpower, zone wise distribution; Network analysis: important terminology, PERT & CPM; concept, origin, application, advantage ,limitation and difference between PERT & CPM.

Practical

Analysis & evaluation of rural development programmes of central and state governments, Preparation of a timeline of Rural development programmes in India ,Visit to a KVK to study their extension activities, Visit to a site of Rural development activities carried out by Panchayat.

Suggested Readings

- Mondal Sagar 2017. Fundamentals of Agricultural Extension Education, Kalyani Publishers, Ludhiana.
- Mondal Sagar 2018 Entrepreneurship Development and Business Communication, Kalyani Publishers, Ludhiana.
- Mondal, Sagar and Boruah, R.(2024) ExtensionLandscape in Global Perspective. Kalyani Publishers, Ludhiana.
- Adhikary M.M, Achraya S.K, Sarkar A and Basu D 2006. Participatory Planning and Project Management in Extension Science, Agrotech Publishing House.

EC 418: Agricultural Business Management 4 (3+1)
Offering Department: AEC

Objectives

- To impart Knowledge on understanding the concepts processes, significance, and role of management and organizational behavior.

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural policy Distinctive features of Agribusiness Management importance and needs of agro-bases industries. Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries. Agri-value chain: Understanding primary and support activities and their linkages. Business environment: PEST and SWOT analysis. Management function: Roles and activities, Organization culture. Planning, meaning, definition, types of plans. Purpose of mission, goals or

objectives, Strategies, polices procedure, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital management and Financialmanagement of Agribusiness. Financial statement and their importance. Marketing Management, Segmentation, targeting and positioning Marketing mix and marketing strategies. Consumer behavior analysis, product life cycle (PLC). Sales and Distribution Management. Pricing policy, various pricing methods, project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and valuation, project Appraisal and evaluation techniques.

Practical

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

Suggested reading

- Broadway, A.C. and Broadway, Arif, A. 2002. A textbook of Agri-Business Management. Kalyani Publishers.
- Bairwa, S.L. 2016. Objective on Fundamentals of Agri-business Management. Kalyani Publishers.
- Anjan Mishra, Debasish Biswas and Arunangshu Giri. 2019. Agribusiness Management. Himalaya Publishing House, 220p.
- Shoji Lal Bairwa, Chandra Sen, L.K. Meena Kumari. 2018. Agribusiness Management, Theory and Practices, Write and Print Publications.
- Virender Karmalvanshi, Agribusiness Management. Random.

EC 419: Agricultural Development Policy Analysis 4 (3+1)
Offering Department: AEC

Theory

Development Economics: Scope and importance of Economic growth and economic development, difference between Economic growth and economic development. Indicators and Measurement of economic development, GNP as a measure of economic growth. New measure of Welfare, NEW and MEW, PQLI, HDI, Green GNP. Criteria for under development. Obstacles to economic development,economic and non- economic factors of economic growth.
Economic Development: meaning, stages of economic development, determinants of economic growth, Theories of economic growth, Ricardian growth model, Harrod-Domar growth model. The Neo-classical model of growth, The Kaldor model, Recent experiences of developing economy, Role of state in economic development, Government measures to promote economic development, Introduction to development planning.
Agricultural Policy: major challenges in Indian Agriculture-national policy---food and nutritional security.
Land policies-reforms: objectives-- importance in India, Land holding systems, ownership private, collective, cooperative, farm tenancy, land tenure and tenancy reforms, ceilings, consequences and implications of Land reforms.

Crop insurance: history, type-agricultural insurance companies, experimental crop insurance, comprehensive crop insurance, NAIS, PMFBY.
Role of agricultural in economic/rural development, transformation of traditional agriculture theories of agricultural development, Lewis, Mellor and Ranis and Fei agricultural growth model.

Practical

Construction of HDI and GHI. Measures of poverty- absolute and relative poverty- head count ratio or poverty rate. Incidence and intensity of poverty- poverty gap, relative poverty gap, The Sen Index, the Thon Index (a variation of the Sen Index). Family of poverty indices by Foster, Greer and Thorbecke, the Hagenaars Index, etc. Identification and assessment of risks in Agriculture, Collection of field data for crop area and yield estimation through Crop cutting Experiment (CCE)- Assessment of crop loss due to natural calamities and insurance claim settlement.

EC 420: Statistical Methods I 4 (3+1)
Offering Department: AST

Theory

Descriptive statistics: probability, probability function, moment generating function, cumulant generating function, characteristics function and their properties, idea of experiment and random experiment, random variable and their properties along with the idea of sigma filed and probability distributions: Discrete probability distributions and properties of these distributions. Continuous probability distributions and properties of these distributions. Sampling distributions of sample mean and sample variance from Normal population, central chi-Square, t and F distributions, and their properties and inter relationships. Correlation, rank correlation, correlation ratio and intra-class correlation. Regression analysis, partial & part and multiple correlation and regression analysis using OLS method, its assumption, properties for both simple and multiple regression. Method of estimation of Parameters, Multicollinearity, Auto-Correlation, Heteroscedasticity, Specification and Identification problem.Matrix and Vector Algebra. Coordinate Geometry in two dimensions. Beta and Gamma Functions. Multivariate Calculus, Double integral. Differential equations, Interpolations. Infinite series, Numerical differentiation and integration. Newton and Raphson Method. Functional units of computer, I/O devices, primary and secondary memories. Programming Fundamentals with C -Algorithm, techniques of problem solving, flowcharting, stepwise refinement; Representation of integer. Character, real, data types; Constants and variables; Arithmetic expressions, assignment statement, logical expression.

Practical

Descriptive statistics, Probability Distributions, Correlation and regression, Programming Fundamentals

Suggested Reading

- Agarwal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd., New Delhi.
- Amble, V. N. 1975. Statistical Methods in Animal Sciences. Indian Society of Agril. Statistics,New Delhi.
- Goon, A. M., Gupta, M.K. and Gupta, B. D. 1979. Fundamental of Statistics. Vol. I and II. TheWorld Press Pvt. Ltd., Kolkata.
- Chakravorty, J.G. and Ghosh, P. R. 1987. Advanced Higher Algebra. U.N. Dhar and Sons Pvt. Ltd. , Kolkata.
- Goulden, C.H. 1959. Methods of Statistical analysis. John Wiley and Sons, New York.

- Gupta, S.C. 1987. Fundamental of Statistics. Himalaya Publishing House, New Delhi.
- Gupta, S.C. and Kapoor, V.K. 1990. Fundamentals of Applied Statistics. Sultan Chand & Sons,New Delhi.
- Gupta, S.P. 2010. Statistical Methods. Sultan Chand and Sons, New Delhi.
- Handbook on Statistical Quality Control. 1986 . Indian Standards Institute, New Delhi.
- Moroney, M.J. 1975. Facts from Figures. Penguin Books, England.
- Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. Oxford and IBH Publishing Co.,New Delhi.
- Agriculture and Applied Statistics I – P K Sahu, Kalynai Publishers.
- Agriculture and Applied Statistics II – P K Sahu and A K Das, Kalynai Publishers.
- Statistical Methods – A Majumder and P K Sahu, Kalynai Publishers.
- Besic Econometrics – Damodar N Gujarati, Mc Graw Hill.

EC 421: Statistical Methods II 4 (3+1)
Offering Department: AST

Theory

Design of experiments: Orthogonal comparisons. Break up of degree of freedom. Analysis of covariance. Missing plot technique in randomized blocks and Latin squares with one missing observation. Transformation of data. Balanced incomplete block designs. Concept of confounding in 2nd and 3rd order factorial designs. Response curve.
Genetical statistics: Estimation of linkage from back cross data, F2 and F3 data. Method of maximum likelihood and other methods of estimation. Disturbed segregation. Estimation of additive genetic, dominance and environmental components of variation. Plant breeding trials and their use in the estimation of genetic variation and variability. Simple ideas of discriminant function for plant selection.
Statistical Inference: Concepts of point estimation: Unbiasedness, consistency, efficiency and sufficiency. Moments, minimum chi-square, least square and maximum likelihood methods of estimation and their properties. Interval estimation-Confidence level, shortest length CI. CI for the parameters of Normal, Exponential, Binomial and Poisson distributions. Fundamentals of hypothesis testing-statistical hypothesis, statistical test, critical region, types of errors, test function, randomized and non-randomized tests, level of significance.

Practical

Design of experiments, Factorial Experiment, Analysis of covariance, Missing plot technique, Analysis of Linkage, Analysis of different components of Genetic variance, Testing of hypothesis

Suggested Reading

- Agarwal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd., New Delhi.
- Amble, V. N. 1975. Statistical Methods in Animal Sciences. Indian Society of Agril. Statistics, New Delhi.
- Goon, A. M., Gupta, M.K. and Gupta, B. D. 1979. Fundamental of Statistics. Vol. I and II. TheWorld Press Pvt. Ltd., Kolkata.
- Goulden, C.H. 1959. Methods of Statistical analysis. John Wiley and Sons, New York.
- Gupta, S.C. 1987. Fundamental of Statistics. Himalaya Publishing House, New Delhi.
- Gupta, S.C. and Kapoor, V.K. 1990. Fundamentals of Applied Statistics. Sultan Chand & Sons, New Delhi.
- Gupta, S.P. 2010. Statistical Methods. Sultan Chand and Sons, New Delhi.
- Handbook on Statistical Quality Control. 1986 . Indian Standards Institute, New Delhi.
- Moroney, M.J. 1975. Facts from Figures. Penguin Books, England.

- Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. Oxford and IBH Publishing Co., New Delhi.
- Das, N. G. 2017. Statistical Methods (vol. 1 and2), Tata McGraw Hill Education.
- Narain P, Statistical Genetics, New Age International publishers, New Delhi.
- M N Das and N C Giri, Design and Analysis Of Experiments- New Age International, New Delhi.
- Estimation and Inferential Statistics – P K Sahu, S R Paland A K Das, Springer, New Delhi.

EC 422: Biotechnology for Crop Improvement 4 (3+1)
Offering Department: ABT

Objectives

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

Theory

Impact of Biotechnology on crop improvement and the perspective of society; Difference between Prokaryotic and Eukaryotic genome, various biotechnological techniques available for crop improvement:

Plant Tissue Culture Technique: Crop improvement using Somaclonal variation, anther/pollen culture and Somatic cell hybridization.

Recombinant DNA Technology& GM Crops: Details of rDNA technique, Direct and Indirect methods of gene transfer in plants; Creation and evaluation of GM crops, Biosafety regulations and their application in Agricultural Biotechnology.

Genome Editing: Various tools of genome editing; CRISPR-Cas9 with specific emphasis on Indian regulations.

Gene Silencing Techniques: Introduction to siRNA and Micro RNA technology

Marker Assisted Breeding and Genomic Selection: Introduction to various DNA-based markers and their use in marker-assisted breeding; Foreground Selection, Recombinant Selection and background Selection; Marker-assisted backcross breeding, marker-assisted selection – success stories; Introduction to Genomic Selection.

Various Molecular Techniques: DNA Extraction, Quality and quantity of isolated DNA, Electrophoresis, PCR and its variants, DNA sequencing technologies.

Introduction to Bioinformatics, Genomics and Proteomics: Concepts of different *omics* techniques, introduction to bioinformatics, Databases and types; DNA sequence analysis, Protein Sequence analysis, Molecular Phyolgenetics.

Practical

Extraction of Plant genomic DNA; Extraction of Vector DNA, Digestion of Vector and Insert, Preparation rDNA molecule, Preparation of Competent Cell, *E. coli.* Transformation, Antibiotic based selection of putative transformants, validation using PCR; Cell Culture, Agarose gel Electrophoresis, SDA-PAGE, Analysis of Primer Characteristics, DNA marker based diversity analysis. Planning of a MABB programme – selection of parents, crossing strategies.

Suggested Readings

- Brown, T. A. 2006. Genomes (3rd edn). Garland Science Pub, New York.
- Gene Cloning and DNA Analysis. 2010. Retrieved from http://biolab.szu.edu.cn/otherweb/lzc/genetic%20engineering/courseware/b1.pdf.
- Green, M. R. and Sambrook, J. 2012. Molecular Cloning: a Laboratory Manual. Cold SpringHarbor, NY: Cold Spring Harbor Laboratory Press.

- Kumar, Pranav and Mina, Usha. 2015. Biotechnology: A Problem Approach. PathfinderPublication.
- Old, R. W., Primrose, S. B. and Twyman, R. M. 2001. Principles of Gene Manipulation andGenomics 7th Edition: Oxford: Blackwell Scientific Publications.
- Ram, HariHar. 2019. Crop Breeding and Biotechnology. Kalyani Publications.
- Rastogi, S.C. 2020. Biotechnology: Principles and Applications. Narosa.
- Sander, J.D. and Joung, J.K. 2014. CRISPR-Cas systems for Editing, Regulating and TargetingGenomes. Nat Biotechnol. 32:347-355.
- Singh, K.H., Kumar, Ajay and Parmar, Nehanjali. 2019. Agricultural Biotechnology at a Glance,science technology.
- Slater. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford, 400p.

EC 423: Plant Bio-chemistry and Molecular Biology 4 (3+1)
Offering Department: ABC

Theory

Carbohydrate biosynthetic Pathways: Photosynthesis -Introduction, photosynthetic pigments, light and dark reactions, photorespiration, C3 and C4 plants;Gluconeogenesis and starch synthesis. Regulation of carbohydrate metabolism.
Nitrogen metabolism: Overview of Nitrogen fixation, nitrate uptake and reduction.
Fatty acid biosynthesis: Overview and regulation.
Amino acid Biosynthesis: Overview and regulation.
Nucleic acid metabolism: DNA replication, transcription and translation, De-novo and salvage pathway of nucleotides synthesis, degradation and regulation.
Secondary metabolites: Classification, biochemistryand applications in food and pharmaceutical industries**.**

Practicals

Estimation of starch, reducing sugar and total carbohydrates; extraction and estimation of phenolics from plant materials; colorimetric estimation of vitamin C in fruits and vegetables; extraction and estimation of chlorophyll, carotenoids, lycopene, curcumin etc. from plant materials; determination of Michaelis-Menten constant; Estimation of enzyme activity of some important plant enzymes,estimation of nucleic acids.

Suggested reading

- Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman (Can be downloaded).
- Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley.
- Horton, Moran, Rawn, Scrimgeour, Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded).
- Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded).
- Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.
- Biochemistry by Donald Voet and Judith G. Voet. Fourth Edition. Wiley (Can be downloaded).
- Biochemistry and Molecular biology of Plants, bob b. Buchanan, 2nd edn , Wiley Blackwell.

EC 424: Plant Developmental Biology 4 (3+1)
Offering Department: PPH

Theory

Unit I- Plant growth, development and differentiation: Definition: Growth, development and differentiation; Growth pattern, Growth habit, Growth formulae Embryogenesis and its different stages,meristems in plant development, Homeobox genes, Development of root, shoot and floral primordia, cell differentiation and its control, cell-cell interaction.
Unity II- Reproductive biology: Alternation of generation, sporogenesis and gametogenesis, pollination and fertilization in flowering plants Introduction of photoperiodism and vernalization, photoperiodic induction, phytochrome structure, multifactorial hypothesis of flowering, molecular basis of floral induction and floral organ development.

Unit III- Response of plants to adverse abiotic factors: Plants' responses to drought, salinity, heat, cold, flood, heavy metals and nutritional deficiency and toxicity. Tolerance mechanism of plants to various abiotic stresses, introduction to osmolytes, oxidative stress and antioxidative mechanisms, heat shock proteins.
Unit IV- Plant growth regulator and crop production: Physiological roles and mode of action of auxin, gibberellins, cytokinins, ethylene and ABA. Novel plant growth regulators- physiological roles of salicylic acid, brassinosteroids, jasmonic acid, polyamines.
Unit V- Applied plant physiology: Photosynthesis in relation to plant productivity, Factors controlling photosynthetic productivity, partitioninig of photosynthate and its regulation, senescence and fruit ripening, soil-less culture and its application to diagnose nutrient deficiencies.

Practical

Introduction to preparation of buffers; Effect of gibberellic acid on dormancy breaking, seed germination and mobilization of food reserves; Determination of content of chlorophylls and carotenoids in leaf sample; Measurement of electrical conductivity of saline solution; Study of pollen sterility; Study of pollen germination and pollen tube growth; Response of plant to abiotic stress in relation to seed germination and early seedling growth; Preparation of standard curve of L-proline; Estimation of proline from plant sample; Determination of membrane damage; Determination of the activity of antioxidative enzymes (peroxidase and catalase); Study of growth indices; Preparation of Hoagland solution; Soil-less cultivation of plants and diagnosis of nutritional disorders.

Suggested readings

- Biochemistry And Molecular Biology of Plants - Bob B. Buchanan, W. Gruissem and R.L. Jones.
- Advanced Plant Physiology – Malcolm B. Wilkins.
- Introduction to Plant Physiology – William G. Hopkins.
- Introductory Plant Physiology- Ray Noggle G. and Fritz G. J.
- Plant Physiology – Robert, M. Devlin and Francis H. Witham.
- Plant Physiology (3rd edition) - Taiz L. and Zeiger E.
- Plant Physiology (4th Indian Edition) - Frank, B. Salisbury and Cleon W. Ross.

EC 425: Advances in Seed Technology 4 (3+1)
Offering Department: SST+AGR

Objectives

- To enrichthe studentson advanced knowledge ofSeed Science and Technology

Theory

Principles of seed production (Introduction, Impact of quality seed in Agriculture, Classes of seeds, role of seed replacement rate (SRR), seed multiplication ratio (SMR); Principles and practices of seed production of field crops (Paddy, Wheat, Maize, Sorghum, Rape seed and mustard, sesame, lentil, green gram and black gram); Principles and practices of seed production of Horticultural crops (Tomato, Pea, Cabbage, Radish, Spices); Principles and practices of hybrid seed production of field crops (Paddy, Maize, Sunflower, Pigeon pea); Concept of Apomixis, male sterility and self-incompatibility (Types, applications, Advantages and disadvantages); Seed Certification (History, concept and objectives of seed certification; seed certification agency/organization and staff requirement Indian Minimum Seed Certification Standards (I.M.S.C.S.) - general and specific crop standards including GM varieties, field and seed standards); Seed Drying (Principles, Methods); Seed processing (Introduction, Objectives, Steps of seed processing, Precautions, Cleaning and grading, Air and screen machines, Dimensional separators, Density separators, Surface texture separators, Colour separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids); Seed sampling (Types, Requirements of sampling, procedure); Basics of seed quality testing (Genetic, Physical, Physiological, and health testing); Seed Treatment (Importance, Methods, Precautions); Packaging and labelling of seeds; Seed Dormancy (Types of Seed Dormancy, Methods to break seed dormancy); Seed Industry (Introduction, Evolution of the seed industry, Development of the vegetable and Flower seed industry); Seed Marketing (Concept, definition and purpose, formal and informal seed supply systems, Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins; packaging and labelling, Factors influencing seed marketing, Seed marketing programs, Seed industry organizations, Demand and supply of seed; Seed pricing and price policy, demand forecasting and factors affecting demand for seeds, effect of price and farm income on seed demand); Synthetic seeds (Components of nutrient media for synthetic seed development, Storage of synthetic seeds Advantages and limitations of synthetic seed production); Biotechnology in Seed Technology (History of plant tissue culture, Laboratory organization, Composition of nutrient medium, Micro-propagation, Axillary bud proliferation approach, Meristem and shoot tip culture, Bud culture, Advantages of Micro-propagation, Problems associated with micro-propagation).

Practical

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

EC 426: Pesticides Chemistry and Technology 4 (3+1)
Offering Department: ACH

Objective

- To impart knowledge on the chemistry of different crop protective chemicals and technology for pesticide formulation and residue analysis.

Theory

Introduction to synthetic and natural pesticides: their type and role in agriculture, effect of pesticides on environment, soil, human and animal health, merits and demerits of pesticide uses in agriculture; **Herbicides:** Indian herbicide scenario,major classes, synthesis, use and MOA of some important herbicides; Fate of herbicides in the environment; **Fungicides**: Classification; Inorganic fungicides: characteristics, preparation and use of sulphur and copper, Mode of action-Bordeaux mixture and copper oxychloride; Organic fungicides: Mode of action, characteristics, preparation and use of Dithiocarbamates- Zineb and Maneb; Systemic fungicides: Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim- characteristics and use; **Insecticides:** Introduction and classification; Inorganic and organic insecticides; Organochlorine, Organophosphates, Carbamates, Natural and Synthetic pyrethroids, Neonicotinoids, IGRs, Reduced risk insecticides; Fate of insecticides in soil & plant; plant and animal systemic insecticides - their characteristics and uses; **Pesticide Formulation**: Purpose of formulation; Components of agrochemical formulation: Carriers, diluents, solvents and surfactants: properties, chemistry; Method of preparation and properties of solid and liquid formulations-Dust, Granule, EC and WP; Bio-pesticide Formulation: Types, properties, merits and demerits. **Pesticide Residue:** Definition, Significance, Free& Bound residue, persistence & dissipation; Basic steps and principle involved in pesticide residue analysis: Sampling, Extraction, Cleanup, Estimation; QuEChERS method of analysis; Recovery experiment, confirmatory analysis; LOD and LOQ; Regression Equation, half-life; Risk Assessment of Pesticide Residues: ADI, MRL, PHI;

Practical

Identifications and acquaintance with glass apparatus and equipment; Pesticides application equipment and their components; Calculation of doses of pesticides for field application; Identification of agro-chemicals using TLC: Preparation of TLC plate, spotting and development, visualization and calculation of R_f; Preparation of glass column for sample clean up, QuEChERS step in vegetable/fruit samples, Determination of copper content in blitox and copper oxychloride; Dithiocarbamate fungicide analysis using CS_2 apparatus; To study and identify various formulations of insecticide available in market; Determination of alkalinity/acidity, suspensibility, Emulsion Stability, Cold Test and Heat Stability of different formulations.

Suggested Readings

- Handa SK, Agnihotri NP and Kulshrestha G. 2000. Pesticide Residue Analysis, Significance, Management and Analysis.
- Hassall KA. 2013. The Chemistry of Pesticides Their Metabolism, Mode of Action and Uses in Crop Protection (ISBN: 9789386237118, 9386237113), Scientific Publishers India, pp 372.
- Panda, H. 2022.The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides (Agrochemicals) with Formulae, Manufacturing Process, Machinery & Equipment Details. 2nd Revised Edition. Niir Project Consultancy Services (NPCS).
- Parmar BS and Tomar SS. 2004. Pesticide Formulation Theory and Practice, CBS Publishers & Distributors-New Delhi, ISBN: 9788123911243, 8123911246.
- Roy N. K. 2002. Chemistry of Pesticides. CBS Publishers & Distributors, New Delhi.

- Singh K. and Singh R. An Introduction to Pesticide Chemistry, 2nd Edition, 2023, Notion Press.
- Valkenburg WV. 2008. Pesticide Formulation: Recent Developments and Their Applications in Developing Countries (ISBN-13: 978-8122410693) New Age International (P) Limited, Publishers; First edition (2008) pp 488.

EC 427: Soil and Water Conservation 4 (3+1)
Offering Department: SWC

Theory

History of soil erosion, definition, classification. Nature and extent soil erosion in India. Mechanics of soil erosion by water and glaciers. Factors and processes of soil erosion; its impact on environment and biosphere. Universal soil loss equation – defining all parameters and its use. Rainfall erosivity and soil erodibility. Mechanics of wind erosion – factors, process, wind erosion equation. Management of soil and nutrient losses. Shifting cultivation – principles, extent and impact. Methods of soil erosion control – vegetative measures like crop rotation, afforestation, agrostological technique, etc. and mechanical measures like contour bunding, trenching, gully plugging, strip cropping, terracing, etc. Conservation farming system. Reclamation of ravine lands. Sand dune stabilization. Grazing and its impact on soil erosion. Forest fire and soil erosion. Control measures of grazing and forest fire.

Practical:

Measurement of flow of runoff water. Collection and quality analysis of runoff water. Analysis of texture and structure of soil. Calculating dispersion ratio, erosion ratio, erodibility index. Measuring rainfall and calculating erosivity index. Measuring soil plasticity, penetrability, porosity etc. Dumpy level survey for preparation of contour map. Land use study using Transect method. Identification of different grasses used for soil conservation.

SEMESTER VIII

Student READY: RAWE/ Industrial Attachment /Experiential Learning / Hands-on Training/ Project Work / Internship (0+20)

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