

RAJASTHAN COLLEGE OF AGRICULTURE : UDAIPUR



Syllabus

Agriculture Faculty
Maharana Pratap University of Agriculture and Technology
Udaipur

UG Curricula as per V Dean's Committee Recommendations
Adopted after Board of Studies Meeting on 20th February 2017

I Semester		
HORT-111	Fundamentals of Horticulture	2 (1+1)
MBB-111	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
SSAC-111	Fundamentals of Soil Science	3(2+1)
FOR-111	Introduction to Forestry	2 (1+1)
ENG-111	Comprehension & Communication Skills in English	2 (1+1)
AGRON-111	Fundamentals of Agronomy	4(3+1)
BIO/MATHS-111	Introductory Biology/Fundamental Mathematics	2(1+1)/ 2(2+0)*
AGRON-112	Agriculture Heritage	1(1+0)*
EXT-111	Rural Sociology & Educational Psychology	2 (2+0)
HVE-111	Human Values & Ethics	1(1+0)**
	NSS/NCC/Physical Education & Yoga Practices	2 (0+2)**
TOTAL		18+03**+03**
*R: Remedial course; **NC: Non-gradual courses		=24
II Semester		
PBG-121	Fundamentals of Genetics	3(2+1)
AGENGG-121	Introductory Soil and Water Conservation Engineering	2(1+1)
PPHY-121	Fundamentals of Crop Physiology	2(1+1)
AGECON-121	Fundamentals of Agricultural Economics	2(2+0)
PPATH-121	Fundamentals of Plant Pathology	3(2+1)
ENVS-121	Environmental Studies and Disaster Management	3(2+1)
EXT-121	Fundamentals of Agricultural Extension Education	3(2+1)
EXT-122	Communication Skills and Personality Development	2(1+1)

LPM-121	Ruminant Production and Management	2 (1+1)
Total		22
III Semester		
AGRON-211	Crop Production Technology – I (<i>Kharif</i> Crops)	3 (2+1)
PBG-211	Fundamentals of Plant Breeding	3 (2+1)
AGECON-211	Agricultural Finance and Cooperation	3 (2+1)
AGI-211	Agriculture Informatics	2(1+1)
AGENGG-211	Farm Machinery and Power	2 (1+1)
HORT-211	Production Technology for Vegetables and Spices	2 (1+1)
AGRON-212	Rainfed Agriculture & Watershed Management	2 (1+1)
LPM-211	Non Ruminant Production and Management	2 (1+1)
ENTO-211	Fundamentals of Entomology	3(2+1)
FSN-211	Principles of Food Science and Nutrition	2(2+0)
Total		24
IV Semester		
AGRON-221	Crop Production Technology –II (<i>Rabi</i> Crops)	3(2+1)
HORT-221	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
AGENGG-221	Renewable Energy and Green Technology	2(1+1)
SSAC-221	Problematic Soils and their Management	2(1+1)
HORT-222	Production Technology for Fruit and Plantation Crops	2(1+1)
PBG-221	Principles of Seed Technology	3(1+2)
AGRON-222	Farming System & Sustainable Agriculture	1(1+0)
AGECON-221	Agricultural Marketing Trade & Prices	3(2+1)
AGRON-223	Introductory Agro-meteorology & Climate Change	2(1+1)
ENTO-221	Management of Beneficial Insects	2(1+1)
	Elective Course	3 credit
Total		22+3(Elective)= 25
V Semester		
PPATH-311	Principles of Integrated Pest and Disease Management	3(2+1)
SSAC-311	Manures, Fertilizers and Soil Fertility Management	3 (2+1)
ENTO-311	Pests of <i>Kharif</i> Crops and their Management and IPM	2 (1+1)

	Concept	
PPATH-312	Diseases of Field and Horticultural Crops and their Management -I	3 (2+1)
PBG-311	Crop Improvement-I (<i>Kharif</i> Crops)	2 (1+1)
EXT-311	Entrepreneurship Development and Business Communication	2 (1+1)
AGRON-311	Geoinformatics and Nano-technology for Precision Farming	2 (1+1)
AGRON-312	Practical Crop Production – I (<i>Kharif</i> crops)	2 (0+2)
PBG-312	Intellectual Property Rights	1(1+0)
	Elective Course	3 credit
Total		20+3(Elective)= 23
VI Semester		
STAT-321	Elementary Statistics	2(1+1)
AGENGG-321	Protected Cultivation and Secondary Agriculture	2 (1+1)
PPATH-321	Diseases of Field and Horticultural Crops and their Management-II	3 (2+1)
HORT-321	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
ENTO-321	Pests of <i>Rabi</i> Crops, Stored Produce and their Management	2 (1+1)
PBG-321	Crop Improvement-II (<i>Rabi</i> Crops)	2 (1+1)
AGRON-321	Practical Crop Production –II (<i>Rabi</i> Crops)	2 (0+2)
AGRON-322	Principles of Organic Farming	2 (1+1)
AGECON-321	Farm Management, Production & Resource Economics	2 (1+1)
NEMAT-321	Fundamental Nematology	2(1+1)
	Elective Course	3 credits
Total		21+3 (Elective)=24
VII Semester		
EXTED-411	Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE &AIA)	20
Total		20

VIII semester

Modules for Skill Development and Entrepreneurship: A student shall register 20 credits opting for two modules of (0+10) credits each (total 20 credits) from the package of modules in the VIII semester.

S. No.	Title of the module	Credits
ENTO-421	Bio-agent Production Sharing with Plant Pathology	0+10
SSAC-421	Bio-fertilizer Production	0+10
PBG-421	Seed Production Technology Sharing with Agronomy	0+10
PPATH-421	Mushroom Cultivation	0+10
SSAC-422	Soil, Plant , Water and Seed Testing services Sharing with PBG	0+10
ENTO-422	Beekeeping	0+10
LPM-421	Poultry Production	0+10
HORT-421	Applied Hi-Tech Horticulture	0+10
AGECON-421	Agri-business Management	0+10
PBG-422	Hybrid Seed Production Technologies	0+10
HORT-422	Floriculture and Landscaping	0+10
FSN-421	Food Processing and Food Safety Standards	0+10
HORT-423	Commercial Vegetable Production	0+10
MBB-421	Tissue Culture Technologies	0+10
AGRON-421	Agriculture Waste Management Sharing with Soil Science	0+10
AGRON-422	Organic Production Technology	0+10
AGRON-423	Agro-advisory Services	0+10
HORT-424	Nursery Management	0+10
ENTO-423	Sericulture	0+10

Elective Courses: A student can select three elective courses out of the following and offer during 4th, 5th and 6th semesters.

S.N.	Courses	Credit Hours
ENTO-222	Agrochemicals	3(2+1)
PBG-222	Commercial Plant Breeding	3(1+2)
SSAC-222	Soil, Plant and Water Testing	3(1+2)
FSN-221	Food Safety Issues	3(2+1)
AGRON-224	Weed Management	3(2+1)
HORT-311	Landscaping	3(2+1)
AGRON-313	Agricultural Waste Management	3(2+1)
AGECO-311	Agri-business Management	3(2+1)
SSAC-312	Bio-fertilizers & Bio-pesticides	3(2+1)
MBB-321	Micro Propagation Technologies	3(1+2)
HORT-322	Protected Cultivation	3(2+1)
EXT-321	Agricultural Journalism	3(2+1)
AGRON-323	Water Management	3(2+1)

Semester wise breakup of credit hours

Semester No.	Regular courses	Remedial courses	Non gradial courses	Electives Courses	RAWE	Modules for Skill Development and Entrepreneurship	Total credit hours
I	18	3	3	-	-	-	24
II	22	-	-	-	-	-	22
III	24	-	-	-	-	-	24
IV	22	-	-	3	-	-	25
V	20	-	-	3	-	-	23
VI	21	-	-	3	-	-	24
VII	-	-	-	-	20	-	20
VIII	-	-	-	-	-	20	20
Total	127	3	3	9	20	20	182

Theory

Horticulture-Its definition and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops; Plant propagation-methods and propagating structures; principles of orchard establishment; Principles and methods of training and pruning, juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy; kitchen gardening; garden types and parts; lawn making; medicinal and aromatic plants; species and condiments; use of plant bio-regulators in horticulture. Irrigation & fertilizers application-method and quantity.

Practical

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

Suggested Readings:

1. Bal, J.S. 1970. Fruit Production. Kalyani Publishers, New Delhi
2. Bose, T.K. and Mitra S.K. (3rd Revised Edition) Vol. I & II. Tropical & Subtropical. Naya Udyog, 206, Bidhan Sarni, Calcutta
3. Shanmugavelu, K.G. 1987. Production Technology of Fruit Crops. SBA Publication, 1/1 Meredith Street, Calcutta
4. Chadha, K.L. (New eds). 2010. Handbook of Horticulture. Indian Council of Agricultural Research, New Delhi
5. A.K. Shukla, R.A. Kaushik, L.N. Mahawer, S. Pareek, D. Pandey and D.K. Sarolia 2008. Adhunik Phalotpadan (Hindi). Communication Centre, MPUAT, Udaipur
6. Peter, K.V. 2009. Basics of Horticulture. New India Publishing Agency, New Delhi.
7. Choudhary, B. 1985. Vegetables. National Book Trust India, New Delhi
8. Purthi, J.S. 2001. Major Spices. Indian Council of Agriculture Research, New Delhi
9. Randhawa, G.S. & Mukhopadhyay, A. 1984. Floriculture in India. Allid Publishers, New Delhi.

MBB 111 Fundamentals of Plant Biochemistry and Biotechnology Credit hours: 3(2+1)

Theory

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

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

Practical

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

Suggested Readings

1. Reginald H. Garnett and Charles M. Grisham (2005). Biochemistry. Thomson Brooks/Cole USA.
2. Goodwin and Mercer (2003) Introduction to Plant Biochemistry. CBS Publishers & Distributors, New Delh
3. Purohit S S (2004) Biotechnology: Fundamentals and Applications 3rd Edn. Student Edition, Jodhpur
4. Chawla H S (2002) Introduction to Plant Biotechnology. 2nd Edn Oxford IBH publishing New Delhi
5. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani.

6. Conn EE & Stumpf PK. 1987. Outlines of Biochemistry. John Wiley.
7. Nelson DL & Cox MM. 2004. Lehninger's Principles of Biochemistry. MacMillan.
8. Seth P and Khandelwal SK.2008. Biochemical Analysis. Himanshu Publications.

Theory

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

Practical

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

Suggested Readings:

1. Boul S.W., Hole R.D., McCracken and Southard R.J. (1998). Soil genesis and classification Fourth Ed Panima Publishing corporation, New delhi.
2. .Baver, L.D. Gardener, W.H. and gardener W.R.(1976) Soil Physics Wiley Eastern Ltd, New Delhi
3. Biswas, T.D. and Mukherjee, S.K. (2006) Text book of soil science. Tata McGraw Hill publishing Co. Ltd, New Delhi
4. Brady, N.C. and Weil, R.R. (2002) The nature and properties of soils, prentice hall of India Pvt. Ltd, M-97, Connaught Circus, New Delhi
5. Das, D.K. (2002) Introductory Soil Science, Kalyani publisher, New Delhi
6. Mehra R.K. (2004) Text book of Soil Science, ICAR, New Delhi
7. ISSS (2009) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi
8. Chopra S.L. and Kanwar, J.S. (1991) Analytical Agricultural Chemistry, Kalyani publisher, Ludhiana
9. Jackson, M.L. (1973) Soil chemical analysis, Prentice Hall of India, Pvt. Ltd New Delhi
10. Piper, C.S. (1950) Soil and plant analysis. .Hans publications, Bombay

11. Richards, L.A. (1960) Diagnosis and improvement of saline and alkali soils., USDA agriculture Hand book 60, Washington D.C., USA
12. Gupta, I.C. & Sharma, S.K. (1988) Crop production in salt affected soils, Oxford and IBH Publication, New Delhi.
13. Agarwal, R.R., Yadav, J.S.P. & Gupta, R.N. (1982) Saline and alkali soils of India. ICAR, New Delhi.
14. Sehgal, J. (2000) Pedology: Concepts and applications, Kalyani publisher, Ludhiana

Theory

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

Practical

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

Suggested Readings

1. Brandis, Dietrich. 1994. Forestry in India : Origins & Early Development, Natraj Publishers
2. Champion, H.G. and Seth, S.K. .1968 A Revised Survey of Forest Types of India, Govt. of India Press, New Delhi
3. Dwivedi, A.P. 2004. A Text Book of Silviculture.IBD Publishers.
4. Chaturvedi, A.N.1982. Forest Mensuration.IBD Publishers, Dehradun
5. Luna,R.K. 2005. Plantation Trees., IBD,Dehradun
6. Ram Prakash, Chaudhari, D.C. and Negi.S.S.1998. Plantation and Nursery Techniques of forest trees.IBD,D'Dun
7. Troup, R.S. 1978. Silviculture of Indian Trees (Vol. I to III) IBD, Dehradun
8. Maslekar, A.R. 1990. Foresters Companion. IBD, Dehradun
9. Upadhyay, C.B.2007. Forest Law: Central & States, Sapna online
10. Dwivedi, A.P. 1992. Agroforestry: Principles and Practices. Oxford & IBH.
11. Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer.

ENG 111 Comprehension and Communication Skills in English Credit hours: 2(1+1)

Theory

War Minus Shooting- The sporting Spirit. A Dilemma- A layman looks at science Raymond B. Fosdick. You and Your English – Spoken English and broken English G.B. Shaw. Reading Comprehension, Vocabulary- Antonym, Synonym, Homophones, Homonyms, often confused words. Exercises to Help the students in the enrichment of vocabulary based on TOEFL and other competitive examinations. Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement, Transformation, Synthesis, Direct and Indirect Narration. Written Skills: Paragraph writing, Precise writing, Report writing and Proposal writing. The Style: Importance of professional writing. Preparation of Curriculum Vitae and Job applications. Synopsis Writing. Interviews: kinds, Importance and process.

Practical

Listening Comprehension: Listening to short talks lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation: rate of speech, clarity of voice, speaking and Listening, politeness & Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: testing initiative, team spirit, leadership, intellectual ability. Group Discussions.

Suggested Readings

1. Saxena, Vivek. 2010. English & Communication Skills, Neelkanth Publishers (P) Ltd. B- 1178, Mangal Marg, Bapu Nagar, Jaipur.
2. Shukla, Punit. 2011. English Communication Skills (In English & Hindi) - College Book House (P) Ltd. Chaura Rasta, Jaipur
3. Peechaatt, James Thomas. 2015. Holy Faith Essential English Grammar & Composition, Holy Faith International (p) Ltd. Gulab Bhawan, 6, Bahadur Shah Zafar Marg, New Delhi.
4. Jain, B.S. English Communication Skills, College Book Centre, A-19, Sethi Colony, Jaipur.

Theory

Agronomy and its scope, seeds and sowing, tillage and tilling, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil plant water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, water logging.

Weeds- importance, classification, crop weed competition, concepts of weed management- principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, Effect of sowing depth on germination and seedling vigour, Identification of weeds in crops, Methods of herbicide and fertilizer application, Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements-reversible plough, one way plough, harrow, leveler, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, bulk density and infiltration rate, Measurement of irrigation water.

Suggested Readings

1. ICAR. 2010. Handbook of Agriculture (6th edition), Indian Council of Agricultural Research, New Delhi.
2. Panda, S.C. 2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
3. Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (2nd edition), Agrobios (India), Jodhpur
4. Reddy, T.Yellamanda and Reddy, G.H. Sankara. 2016. Principles of Agronomy (2nd edition) , Kalyani Publishers, Ludhiana
5. Reddy, S.R.2012. Principles of Crop Production (4th edition), Kalyani Publishers, Ludhiana.
6. Tomar, Gajendra Singh. 2010. Agronomy Basics and Applied. Satish Serial Publishing House, Azadpur, New Delhi.
7. आर्य, आर. एल. एवं कुरील, आर. एस. 2016. सस्य विज्ञान के सिद्धान्त, साइंटिफिक पब्लिशर्स, जोधपुर
8. पोरवाल, बी. एल., सिंह, पुष्पेन्द्र एवम् शर्मा, डी. डी. 2000. सस्य विज्ञान के मूल तत्व, के. पी. प्रकाशन, उदयपुर

BIO 111

Introductory Biology

Credit hours: 2(1+1)

Theory

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

Practical

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

Suggested Readings

1. Sharma, R.C. 2014. Systematic Biology. Kalyani Publishers
2. Arora, B.B. and Sabharwal, A.K. 2017. Modern's ABC of Biology. Modern Publishers, Lucknow.
3. Arora, D.K. and Trivedi, P.C. A text book of Botany. Ramesh Book Depot, Jaipur.
4. Hussain, Khalid and Nawaz, Khalid. 2014. Introductory plant taxonomy. Kalyani Publishers.

Theory

Straight lines : Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral. Circle: Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points (x_1, y_1) & (x_2, y_2) , Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$. Differential Calculus : Definition of function, limit and continuity, Simple problems on limit, Simple problems on continuity, Differentiation of x^n , e^x , $\sin x$ & $\cos x$ from first principle, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problems based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form $y=f(x)$ (Simple problems based on it).

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

Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation.

Suggested Readings

1. Gokhroo, D.C and Jain Krishi Ganita, Alka Publication Ajmer.
2. Surjeet Singh & : Modern Algebra Quazi Zameeruddin.
3. I.N.Herstein : Topics in algebra 3. R.S.Agrawal : Algebra.
4. Gokhroo, Saini : Advanced Abstract Algebra.

Theory

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

Suggested Readings

1. Nene, Y.L. 2007. Glimpses of the Agriculture Heritage of India, Asian Agri-History Foundation, Marketing by Munshiram Manoharal Publishers Pvt. Ltd,
2. Saxena, R.C., Choudhary, S.L. and Nene, Y.L.2009. Textbook on Ancient History of Indian Agriculture, Asian Agri-History Foundation.
3. Kumari, D. and Manimuthu Veeral. 2014. Text Book on Agricultural Heritage of India. Agrotech Publishing Academy, Udaipur
4. ICAR. Introductory Agriculture. ICAR e-course. Indian Council of Agricultural Research, New Delhi. (<http://www.agrimoon.com/wp-content/uploads/Introductory-Agriculture.pdf>)
5. चौधरी, शिवचरण लाल. 2003. वृक्षायुर्वेद (वनस्पति जीवन का विज्ञान), एशियन एग्री-हिस्ट्री फाउण्डेशन, उदयपुर
6. खण्डेलवाल, एस. के. एवं चौधरी शिवचरण लाल. 2011. कृषि-पराशर (पराशर के अनुसार कृषि), एशियन एग्री-हिस्ट्री फाउण्डेशन, उदयपुर
7. खण्डेलवाल, एस. के. एवं चौधरी शिवचरण लाल. 2013. उपवनविनोद: (आनंद के लिए वनस्थली उद्यान), एशियन एग्री-हिस्ट्री फाउण्डेशन, उदयपुर
8. Randhawa, M.S. 1980. A History of Agriculture in India Vol. I, ICAR, New Delhi
9. Randhawa, M.S. 1982. A History of Agriculture in India Vol. II, ICAR, New Delhi
10. Randhawa, M.S. 1983. A History of Agriculture in India Vol. III, ICAR, New Delhi
11. Randhawa, M.S. 1986. A History of Agriculture in India Vol. IV, ICAR, New Delhi

EXT 111

Rural Sociology & Educational Psychology

Credit hours: 2(2+0)

Theory

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

Suggested readings

Chitambar, J.B. 1973. Introductory rural sociology. John Wiley and Sons New York.

Desai, A.R. 1978. Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. Ed.

Doshi, S.L. 2007. Rural sociology. Rawat Publishers, Delhi.

Jayapalan, N. 2002. Rural sociology. Altanic Publishers New Delhi.

Sharma, K.L. 1997. Rural society in India. Rawat Publishers, Delhi.

Maslow, A.H. 1970. Motivation and personality. Harper and Row publishers , New York.

Perelson, B. and Steiner, G. 1964. Human behaviour. Harcourt Brace Jovanovich , New York.

HVE 111

Human Value and Ethics

Credit Hours 1(1+0)

Theory

Values and Ethics-An Introduction. Goal and Mission of Life. Vision of Life. Principles and Philosophy. Self Exploration. Self Awareness. Self Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

Suggested Readings

Gaur, R.R., Sangal, R. & Bagaria, G.P. 2011. A Foundation Course in Human Values and Professional Ethics. Excel Books.

Mathur, S.S. 2010. Education for Values, Environment and Human Rights. RSA International.

Sharma, R.A. 2011. Human Values and Education -Axiology, Inculcation and Research. R. Lall Book Depot.

Sharma, R.P. & Sharma, M. 2011. Value Education and Professional Ethics. Kanishka Publishers.

Srivastava, S. 2011. Human Values and Professional Ethics. S K Kataria & Sons.

Srivastava, S. 2011. Environmental Science. S K Kataria & Sons.

Tripathi, A.N. 2009. Human Values. New Age International (P) Ltd. Publishers.

NSS/NCC/Physical Education & Yoga Practices Credit hours: 2(0+2)

Theory

Course aims at evoking social consciousness among students through various activities viz., working together, constructive and creative social work, to be skilful in executing democratic leadership, developing skill in programme development to be able for self employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Following activities are to be taken up under the NSS course:

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

All the activities related to the National Service Scheme course is distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme

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

SYLLABUS

Semester I

Course Title: National Service Scheme I

Introduction and basic components of NSS:

Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

NSS programmes and activities

Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth

Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilisation

Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation 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 shramdan

Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan 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.

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity, Cell division – mitosis, meiosis, Probability and Chi-square. Dominance relationships, gene interaction.

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 mechanisms, chromosome mapping. Structural changes in chromosome, Mutation, classification, Methods of inducing mutation & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Epistatic interactions with examples. Cytoplasmic inheritance. Genetic disorders,. Nature, structure & 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. Study of cell structure. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and cross over analysis (through two point test cross and three point test cross data). Study on sex linked inheritance in *Drosophila*. Study of models on DNA and RNA structure.

Suggested Readings:

- Gupta,P.K.2016. Cytology, Genetics and evaluation Rastogi Publications Meerut (Hindi edition).
Gupta, P.K. 2007. Genetics. Rastogi Publications, Meerut.
Klug, W.W. and Cummings, M.R. 2005. Concepts of Genetics Pearson Education (Singapore) Pvt.Ltd. Indian Branch, Pratapganj, New Delhi.
Pundhan Singh, 2000. Elements of Genetics. Kalyani Publishers, Ludhiana.
R.K.Ramchandra,2015.Principles of Genetics,Jaya Publishing House,Delhi.
Singh. B.D. 2015. Genetics, Kalyani Publishers,New Delhi.
Singh, B.D. 2007. Fundamentals of Genetics. Kalyani Publishers, Ludhiana.
Snusted, D. P. and Simmons, M. J. 2010. Principles of Genetics. John Wiley & Sons.
Strickberger, M.W. 2004. Genetics. Prentice – Hall of India Pvt. Ltd., New Delhi.
Verma, P.S. and Agarwal, V.K. 2005. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand and Co., New Delhi.

AGENGG-121 Introductory Soil and Water Conservation Credit hours: 2(1+1)
Engineering

Theory

Surveying: Acquaintance with chain survey and dumpy level survey equipment and contouring. Introduction to Soil and Water Conservation causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms and mechanics of water erosion. Gully classification and control measures. Introduction of soil loss by Universal Soil Loss Equation (USLE). Principles of erosion control: Introduction to strip cropping, Contour bund, Graded bund, bench terracing and Grassed waterways. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

Surveying: Acquaintance with chain survey and dumpy level survey equipment. General status of soil conservation in India. Study of measures. Study of raingauges and mass curve. Measurement of soil loss. Preparation of contour maps. Problem on wind erosion. Field visit to watershed.

Suggested Readings

1. Suresh, R. 2006. Soil and Water Conservation Engineering, Standard Publisher Distributor, New Delhi.
2. Kanetkar T. P. and Kulkarni S. V. 1981. Surveying and levelling vol.1 Vidyarthi Griha Prakash, Pune.
3. Murthy, V.V.N. 1982. Land and Water Management Engineering, Kalyani Publishers, New Delhi.
4. Michael, A.M. and Ojha, T.P. 1993. Principles of Agricultural Engineering – vol II, Jain Brothers, New Delhi.

Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; Photosynthesis: Light and Dark reactions, C₃, C₄ and CAM plants; Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism: Fatty acid synthesis and Breakdown; Plant growth regulators: Physiological roles and agricultural uses, Physiological aspects of growth and development of major crops: Growth analysis, Role of Physiological growth parameters in crop productivity.

Practical

Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, Separation of photosynthetic pigments through paper chromatography, Rate of transpiration, photosynthesis, respiration, tissue test for mineral nutrients, estimation of relative water content, Measurement of photosynthetic CO₂ assimilation by Infra Red Gas Analyzer (IRGA).

Suggested Readings

1. Pandey, S.N. and Sinha, B.K. 1977. Plant Physiology. Vikas Publishing House Pvt. Ltd, New Delhi.
2. Kumar, A. and Purohit, S.S. 1998. Plant Physiology Fundamental and Application. Agrobotanica 4E 176 J.N. Vyas Nagar, Bikaner.
3. Gupta, N.K. and Gupta, S. 2005. Plant Physiology. Oxford & IBH, New Delhi.
4. Bala, M., Gupta, S. and Gupta, N.K., 2013. Practicals in Plant Physiology. Scientific Publisher, Jodhpur.
5. Bagdi, D.L. 2016. Crop Physiology. New India Publishing Agency, New Delhi.

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. *Demand*: meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. *Laws of returns*: Law of variable proportions and law of returns to scale. *Cost*: Cost concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break even points. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. *National income*: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programmes on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy. Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure. *Tax*: meaning, direct and indirect taxes, agricultural taxation, VAT. *Economic systems*: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

Suggested readings:

1. Dominick Salvatore, 2011, Outline of Microeconomics, Schaum's Outline Series.
2. I. Bhavani Devi, P. Raghu Ram, S. Subba Reddy, T.V. Neelakanta Sastry, 2009, Agricultural economics, Oxford and IBH Co. Pvt. Ltd., New Delhi.
3. K. K. Dewett and J. D. Varma, 1986, Elementary Economic Theory, S. Chand & Company, New Delhi.
4. Latika Sharma *et al* (2014) Principles of agricultural economics, Agrotech publishers, Udaipur.
5. M.L. Jhingan, 2004, Micro Economic Theory, Vikas Publishing House Pvt. Ltd., New Delhi.

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

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

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

Viruses: nature, architecture, multiplication and transmission.

Study of phanerogamic plant parasites.

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

Principles and methods of plant disease management.

Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipments and microscopy. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites.

Study of morphological features and identification of plant parasitic nematodes. Extraction of nematodes from soil.

Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

Suggested Reading:-

Alexopoulos, C.J., Mims, C.W. and Blackwell, M, 1996. Introductory Mycology. John Wiley and Sons Ltd., N.York.

Mehrotra, R.S. and Aneja, K.R., 1990. Introduction to Mycology Wiley E.Ltd., New Delhi.

Dube, H.C. A text book of Fungi, Bacteria and Viruses, Vikas Publishing House, P.Ltd., New Delhi.

Singh, R.S. 1982. Plant Pathogens – The Fungi. Oxford and IBH Publishing Co., New Delhi.

- Singh, R.S. 1989. Plant Pathogens – The Prokaryotes. Oxford and IBH Publishing Co., New Delhi
- Mandahar,C.L. 1987. Introduction to Plant Viruses – Chand & Co.Pvt.Ltd., New Delhi.
- Nene,Y.L. and Thapliyal P.N. 1993. Fungicides in Plant disease control. Oxford & IBH Publishing Co.,New Delhi.
- Upadhyay R.K.,Mukherji K.G. and Rajak R.L. 1997 .IPM Systems in Agriculture, Vol.2 In: Biocontrol in Emerging Biotechnology Aditya Books (P) Ltd, New Delhi.
- Singh,R.S.1984 Introduction to Principles of Plant Pathology, Oxford & IBH Publishing Co., New Delhi.
- Agrios G.N. 2005. (5th Edition) Plant Pathology, Elsevier Academic Press, New York,
- Chaube, H.S. and Singh, R.2001. Introductory Plant Pathology. International Book Distributing Co. Lucknow.

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance.

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

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

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

Social Issues and the Environment: From Unsustainable to Sustainable development, 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. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

DISASTER MANAGEMENT

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site- Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Suggested Readings

1. Choudhary, B.L. and Pandey, J. 2004. Environmental Studies, Apex Publishing House, Udaipur.
2. Satyanarayan, Shanta, Zade, Suresh, Sitre, Shashikant and Pravin Meshram. A Text Book of Environmental Studies. 2009. Allied Publishers Pvt. Ltd., New Delhi.
3. Bamaniya, B.R., Verma, L. N. and Verma A. 2005. Fundamentals of Environmental Studies, Yash Publishing House, Bikaner.
4. Rathore, N. S. and Singh, Pratap 2004. Environmental Studies. Himanshu Publishing House, New Delhi.
5. चौधरी, बी. एल. एवं पांडे, जितेन्द्र. 2004. पर्यावरण अध्ययन, एपेक्स पब्लिशिंग हाउस, उदयपुर।
6. कौशिक, अनुभा एवं कौशिक, सी. पी. 2005. पर्यावरण अध्ययन, न्यू एज इन्टरनेशनल (प्रा) लिमिटेड, नई दिल्ली।
7. जागेटिया, बी. एल. और पुरोहित, पंकज 2005. पर्यावरण अध्ययन, एग्रोटेक पब्लिशिंग एकेडमी, उदयपुर।

Theory

Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning- Meaning, Process, Principles and Steps in Programme Development. Extension systems in India: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND,NATP, NAIP, etc.). New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc.

Rural Development: concept, meaning, definition; various rural development programmes launched by Govt. of India. Community Dev.-meaning, definition, concept & principles, Physiology of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, media mix strategies; communication: meaning and definition; models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

Acquainting students with university extension system. Visit to nearby village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA and other development departments at district level; visit to NGO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; visit to basic village institutions and self help groups; to study the structure and functioning of MNREGA and other development schemes.

Suggested readings

- 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.
- Jalihal, K. A. and Veerabhadraiah, V. 2007. Fundamentals of Extension Education and Management in Extension. Concept publishing company, New Delhi.
- Sagar Mondal and Ray, G. L. 2004. Text Book on Rural Development, Entrepreneurship And Communication Skills. Kalyani Publications.
- Rathore, O. S. *et al.*, 2012. Handbook of Extension Education. Agrotech Publishing Academy, Udaipur.

- Ray, G. L. 1991. Extension Communication and Management. Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
- Supe, S. V. 2013. A Text Book of Extension Education. Agro-tech Publishing Academy, Udaipur.

EXT-122 Communication skills and Personality Development Credit hours: 2(1+1)

Theory

Communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, public speaking; Group discussion. Organizing seminars and conferences.

Diffusion and adoption of innovations: concept and meaning, process and stages of adoption, adopters categories. 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.

Practical

Practicing listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Precise writing, summarizing, abstracting; Group discussion- exercise, Handling and use of audio visual equipments, digital camera and LCD projector; preparation and use of AV aids, preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; Presentation skills exercise; micro teaching exercise; exposure to mass media: visit to community radio and television studio for understanding the process of programme production; script writing, writing for print and electronic media, developing script for radio and television.

Suggested readings

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.

Jalihai, K. A. and Veerabhadraiah, V. 2007. Fundamentals of Extension Education and Management in Extension. Concept publishing company, New Delhi.

Sagar Mondal and Ray, G. L. 2004. Text Book on Rural Development, Entrepreneurship and Communication Skills. Kalyani Publications.

Rathore, O. S. 2012, Handbook of Extension Education. Agro-tech Publishing Academy, Udaipur.

Ray, G. L., 1991. Extension Communication and Management. Kalyani Publishers, Ludhiana
{7th revised edition – 2010}.

M. Hilaris (2011). Indian agriculture and information: Soundari. New century Publications.

LPM 121

Ruminant Production and Management

Credit hours: 4(3+1)

Theory

Role of livestock in the national economy. Reproduction in farm animals, Housing principles and space requirements for different species of livestock. Management of calves, growing heifers and milch animals. Management of sheep and goat. Important Indian and exotic breeds of cattle, buffalo, sheep and goat. Classification of feedstuffs. Nutrients and their functions. Feeding of livestock. Introduction of livestock diseases, Prevention and control of important diseases of livestock.

Practicals

External body parts of cattle, buffalo, sheep, and goat. Handling and restraining of livestock. Identification methods of farm animals. Daily routine farm operations and farm records. Judging of cattle and buffalo. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Economics of cattle, buffalo, sheep and goat.

Suggested Readings

1. Banerjee, G.C. 1989. Text Book of Animal Husbandry. Oxford and IBH.
2. Chaudhary, J.L., Gupta, Lokesh and Gupta, A.K. 2015. Text Book of Animal Production. Agrotech Pub. Academy.
3. Sastry, NSR & Thomas, C.K. 1991. Dairy Bovine Production. Kalyani Publisher.
4. Thomas, C.K., Sastry, NSR. 2013. Livestock Production Management. Kalyani Publisher.

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses-pigeonpea, mungbean and urdbean; oilseeds- groundnut, and soybean; fibre crops- cotton & Jute; forage crops-sorghum, cowpea, cluster bean 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 varieties and important agronomic experiments at experimental farm. study of forage experiments, morphological description of kharif season crops, visit to research centres of related crops.

Suggested Readings

1. Singh, Chhidda, Singh, Prem and Singh, Rajbir. 2003. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co., New Delhi.
2. Panda, S.C.2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
3. Singh, S.S.and Singh, Rajesh. 2013. Crop Management Under Irrigated and Rainfed Conditions. Kalyani Publishers, New Delhi.
4. Singh, S.S.and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.
5. Rathore, P.S. 2000. Techniques and Management of Field Crop Production, Agrobios (India), Jodhpur.
6. Prasad, Rajendra. 2002. Text Book of Field Crops Production, ICAR, New Delhi.
7. ICAR. 2010. Handbook of Agriculture (6th edition), Indian Council of Agricultural Research, New Delhi
8. Reddy, S.R. 2012. Agronomy of Field Crops. Kalyani Publishers, Ludhiana.
9. www.tnau.ac.in Link Student Resources-eagri.tnau.ac.in
10. आर्य, आर.एल एवं आर्य, केशव. 2016. खरीफ सस्य उत्पादन, कल्याणी पब्लिशर्स, लुधियाना
शक्तावत, मोहन सिंह एवं व्यास, अभय कुमार. 2000. वैज्ञानिक फसल प्रबन्धन, यश पब्लिशिंग हाउस, बीकानेर

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self – incompatibility and male sterility- genetic consequences, cultivar options. Domestication, Acclimatization, introduction; Centre of origin/diversity, component 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; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Wide hybridization and pre-breeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical

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

Suggested Readings:

- Allard, R.W. 2000. Principles of Plant Breeding, John Wiley & Sons. New York.
- Blumm, A. 1988. Plant Breeding for Stress Environments. CRC Press Inc., USA
- Chahel, G.S. and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding, Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi.
- Chopra, V.L. 2001. Breeding Field Crops. Oxford & IBH Publishing Co Pvt Ltd, New Delhi
- Chopra, V.L. 2004. Plant Breeding. Oxford & IBH Publishing Co Pvt Ltd, New Delhi
- Chopra, V.L. and Shyam Prakash. 2002. Evolution and adaptation of cereal crops. Oxford and IBH Publishing Co Pvt Ltd, New Delhi
- Poehlman, J.M. and Borthakur, D.N. 1972. Breeding Asian Field Crops. Oxford & IBH.
- Roy, Darbeshwar. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
- R.K. Ramchandra, 2015. Principles of Plant Breeding, Jaya Publishing House, Delhi
- Sharma, J.R. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Simmonds, N.W. 1990. Principles of Crop Improvement. English Language Book Society.
- Singh, B.D. 2006. Plant Breeding. Kalyani. Publishers, New Delhi
- Snustad, D. P. and Simmons M.J. 2006. Genetics, 4th Ed. John Wiley & Sons.

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms – SWOT analysis.

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

Practical

Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. 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. Different types of repayment plans.

Suggested readings:

1. I. Bhavani Devi, P. Raghu Ram, S. Subba Reddy, T.V. Neelakanta Sastry, 2009, Agricultural economics, Oxford and IBH Co. Pvt. Ltd., New Delhi.
2. Kamat, G.S., 1978, New Dimensions of Cooperative Management, Himalyan Publishing House, Mumbai.
3. Nelson and Murray, 1988. Agricultural Finance. Kalyani Publishers, New Delhi.
4. Pandey, U.K. 1990. An Introduction to Agricultural Finance, Kalyani Publishers, New Delhi.
5. Singh, J.P., 1988, Agricultural Finance Theory and Practices, Ashish Publishing House, New Delhi.
6. Muniraj, R. 1987, Farm finance for development, Oxford & IBH Pub. Co., New Delhi.

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System, types of operating system, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, tabulation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, creating database, uses of DBMS in Agriculture, Internet and World Wide Web (WWW), Concepts, components and creation of HTML, XML coding.

Computer Programming, General Concepts, Introduction to programming languages concepts and standard input/output operations, variable and constantans, operators and expressions, Flow of control, Inbuilt and User defined functions, programming techniques for agriculture.

E-Agriculture, concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in Agriculture. ICT for data collection, IT application for computation of water and nutrient requirement of crops etc., Computer controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advises, market price, post-harvest management tec., Introduction to DSS and its role in agriculture, Introduction and role of expert system in agriculture.

Practical

Study of Computer Components, accessories. Introduction to different operating systems such as WINDOW,UNIX, LYNUX, creating, files and folders, File management. Use of MS-WORD and MS Power Point for creating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, art tool, graphics, template and designs. MS-Excel-creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-Information system.

Introduction to World Wide Web (WWW) and its components. Introduction to HTML, Use of smart phones and other devices in agro-advisory and dissemination of market information.

Suggested Reading:

1. Internet: The Complete Reference 2 Sub Edition by Margaret Levine Young.
2. Office 2013 All-In-One For Dummies by Peter Weverka.
3. Computer Fundamentals (With CD) 6th Edition 6th Edition by Pradeep Sinha and Priti Sinha.
4. Principles of Programming Languages by Er. Anil Panghal.
5. E-Agriculture and Rural Development by Charalampos Patrikakis, Blessing Maumbe.

Theory

Status of Farm Power in India, Sources of Farm Power , I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication ,fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor , Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage 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

Different components of an I.C. engine, 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, familiarization with brake, steering, hydraulic control, tractor driving, familiarization with operation of power tiller, familiarization with mould plough, disc plough, disc harrow, seed-cum-fertilizer drills, planters and calibration, familiarization with different types of sprayers and dusters, familiarization with harvesting and threshing machinery, familiarization with implements for hill agriculture.

Suggested Readings

1. Michael, A.M. and Ojha, T.P. 1993, Principals of Agricultural Engineering, Jain Brothers, New Delhi.
2. Sahay, Jagdishwar. 1992. Elements of Agricultural Engineering, Agro Book Agency, Patna.
3. Nakra, C.P. 1970. Farm Machinery & Equipment, Dhanapat Rai and Sons, New Delhi.

Theory

Importance of vegetables & spices in human nutrition and national economy, brief about origin, area, production, improved varieties and cultivation practices such as time of sowing, sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting, storage, physiological disorders, disease and pest control and seed production of important vegetable and spices crop-solanaceous (tomato, brinjal, chilli), cucurbitaceous (bottle gourd, round gourd, bitter gourd, water melon, musk melon, pumpkin, ridge gourd, sponge gourd), cole crops (cabbage, cauliflower, broccolli), Bulb crops (Onion, garlic), tuber crops (sweet potato, greater yam, colocasia), leafy vegetables (amaranthus, spinach,), root crops (turnip, raddish, carrot), other vegetables (peas, okra, cowpea, cluster bean and pointed gourd), spices- cumin, coriander, fennel, fenugreek, ginger, turmeric, black pepper, cardamom.

Practical

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

Suggested Readings:

1. Chadha, K.L. & Kaloo, G. Advances in Horticulture. Vol.5&6. Vegetable Crops; Malhotra Publishing House, New Delhi.
2. Chaudhary, B. 1996. Vegetables, NBT, New Delhi
3. Bose, T.K., Kabir, J., Maity, T.K., Parthasarthy, V.A. and Sons, M.G. 2006. Vegetable Crops, Vol.I,II&III (IIIrd revised edition).
4. Singh, S.P. 1989. Production Technology of Vegetable Crops, Agril. Research, Communication Centre, Karnal.
5. Chadha, K.L.. 2010. Handbook of Horticulture (New eds). Indian Council of Agricultural Research, New Delhi
6. Purthi, J.S. 2001. Major Spices. Indian Council of Agriculture Research, New Delhi
7. Sen, N.L., Dashora, L.K. and Dashora, A. 2003. Ropen Phaslein, Masalein, Sughandit avem Aushadhyia Poudhay. Alka Publication, Ajmer (Raj.)

Theory

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

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different dry land areas in the country and demarcation of dry land area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. effective rainfall and its calculation. Studies on cultural practices viz; mulching, plant density, depth of sowing, seed soaking and seed treatments with chemicals, thinning and leaf removal for mitigating moisture stress. Calculations on moisture deficit and aridity index, Characterization and delineation of model watershed. Field demonstration on construction of water harvesting structures. Acquaintance with different soil conservation structures, identification of grasses and tree species for soil and water conservation. Visit to model watershed area/ dryland research station.

Suggested Readings

1. Jayanthi, C. and Kalpana, R. 2016. Dryland Agriculture, Kalyani Publishers, Ludhiana.
2. Reddy, S.R. and Reddy, G. Prabhakara. 2015. Dryland Agriculture, Kalyani Publishers, Ludhiana.
3. Murthy, J. V. S. 1994. Watershed Management, Wiley Eastern Limited. New Age International Limited, New Delhi.
4. Dhruva Narayan, V.V. Singh, P.P., Bhardwaj, S.P., U. Sharma, Sikha, A.K., Vital, K.P.R. and Das, S.K. 1987. Watershed Management for Drought Mitigation, ICAR, New Delhi.
5. Singh, R.P., Sharma, S., Padmnabhan, N.V. , Das, S.K. and Mishra, P.K. 1990.A Field Manual on Watershed Management, ICAR (CRIDA), Hyderabad.
Singh, P.K. 2000. Watershed Management (Design & Practices), e-media Publication, Udaipur, India.

Theory

Role of poultry and pigs in the national economy. Reproduction in pigs and poultry. Housing principles and space requirements for pigs and poultry. Care and management of boar, pregnant sow, piglets, and lactating sow. Incubation, hatching and brooding. Management of growers and layers and broilers. Important Indian and exotic breeds of swine and poultry. Feed and feeding of pigs and poultry.

Practical

External body parts of swine and poultry. Handling and restraining of poultry. Identification methods of pigs and poultry. Farm records. Judging and culling of poultry. Planning and layout of housing for different types of poultry and pig. Computation of rations for pigs and poultry. Hatchery operations. Selection and care of hatching eggs. Incubation and hatching equipments. Debeaking, dusting and vaccination.

Suggested Readings

1. Banerjee, G.C. 1989. Text Book of Animal Husbandry. Oxford and IBH.
2. Chaudhary, J.L., Gupta, Lokesh and Gupta, A.K. 2015. Text Book of Animal Production. Agrotech Pub. Academy.
3. Prasad Jagdish. 2001. Poultry Production and Management. Kalyani Publisher.
4. Sharda, D.P. 2000. Swine Production. ICAR, New Delhi

Part - I

History of Entomology in India. Factors for insect's abundance. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and 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. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

Part-II

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors—temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance. Concepts of Balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem.

Part III

Pest surveillance and pest forecasting. Categories of pests. Host plant resistance, Cultural, Mechanical, Physical. Legislative. Biological (parasites, predators & transgenic plant pathogens such as bacteria, fungi and viruses) methods of control. Chemical control-importance, hazards and limitations. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Practices, scope and limitations of IPM. Insecticides Act 1968-Important provisions. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Beneficial insects: parasites and predators used in pest control and their mass multiplication techniques. Important groups of microorganisms, bacteria, viruses and fungi used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers, their importance.

Part – IV

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

Practical:

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

Suggested Readings:

1. Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
2. Nayar, K.K., Ananthakrishnan, T.N. and David. B.V. 1976. *General and Applied Entomology*. McGraw Hill Publishing Co. Ltd., New Delhi.
3. Richards, O.W. and Davies, R.G. 1977. *Imm's General Text Book of Entomology*, Vol. I & II. Chapman and Hall, London.
4. Pant N.C. and Ghai, S., 1981. *Insect Physiology and Anatomy*, ICAR.
5. Romoser, W.S. and Staffolano, W.S. Jr. 1994. *The Science of Entomology*. III Edition, Winn C. Brown Publishers.
6. Gullan, P.J. and Cranston, P.S. 2005. *Insects: an outline of entomology*, III edition Chapman & Hall Publication.
7. Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
8. Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi.
9. Gillott, C. 1995. *Entomology*, 2nd Ed. Plenum Press, New York, London.
10. Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects*. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.
11. Southwood TRE & Henderson PA. 2000. *Ecological Methods*. 3rd Ed. Methuen & Co. Ltd., London.
12. Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York.

Theory

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

Suggested Readings

1. Manay, S. and Shadaksharaswamy, M. 2001. Foods: Facts and Principles, II Edition. Published by New Age International P (Ltd.) Publishers. Reprint 2003.
2. Sharma, A. 2010. Text book of Food Science & Technology, 2nd Revised and Enlarged Edition. Ibdc Publishers.
3. Swaminathan, M. 1998. Advanced Text-Bok on Food & Nutrition, Vol.I, Revised and Enlarged Edition Published by The Bangalore Printing And Publishing Co.Ltd.
4. Robert L. Shewfelt. 2013. Introducing Food Science. CRC press.

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices, plant protection measures and yield of *Rabi* crops; cereals –wheat and barley, pulses-chickpea, lentil, peas, oilseeds-rape seed, mustard, linseed and sunflower; sugar crops-sugarcane; other crops- potato, Forage crops-berseem, lucerne and oats; Medicinal crops: isabgol and opium poppy

Practical

Field preparation for sowing of *rabi* crops, 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

1. Singh, Chhidda, Singh, Prem and Singh, Rajbir. 2003. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co., New Delhi.
2. Panda, S.C.2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
3. Singh, S.S.and Singh, Rajesh. 2013. Crop Management Under Irrigated and Rainfed Conditions. Kalyani Publishers, New Delhi.
4. Rathore, P.S. 2000. Techniques and Management of Field Crop Production, Agrobios (India), Jodhpur.
5. Prasad, Rajendra. 2002. Text Book of Field Crops Production, ICAR, New Delhi.
6. ICAR. 2010. Handbook of Agriculture (6th edition), Indian Council of Agricultural Research, New Delhi.
7. Reddy, S.R. 2012. Agronomy of Field Crops. Kalyani Books, New Delhi.
8. www.tnau.ac.in Link Student Resources-eagri.tnau.ac.in
9. आर्य, आर.एल एवं आर्य, केशव. 2016. खरीफ सस्य उत्पादन, कल्याणी पब्लिशर्स, लुधियाना
शक्तावत, मोहन सिंह एवं व्यास, अभय कुमार. 2000. वैज्ञानिक फसल प्रबन्धन, यश पब्लिशिंग हाउस, बीकानेर

HORT 221 Production Technology for Ornamental Crops, MAPs and Landscaping Credit hours: 2(1+1)

Theory

Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, liliium and orchids under protected conditions and gladiolus, tuberose, chrysanthemum, gaillardia under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol, safed musli, opium, senna and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Processing and value addition in ornamental crops and MAPs produce.

Practical

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

Suggested Readings:

1. Yadav, L.P. & Bose, T.K. 1988. Commercial flowers, Naya Prakash, Calcutta.
2. Randhawa, G.S. & Mukhopadhyay, A. 1984. Floriculture in India. Horticulture and allied Publishers, New Delhi.
3. Prakash, J and Bhandari K.R. 1994. Floriculture Technology. Traders & Trends. Oxford and IBH Publishing Co. Pvt. Ltd.
4. Swaroop V.S. 1984. Flowers. National Book Trust, New Delhi, India
5. Bose, T.K., Maiti, R.G, Dhua, R.S and Das, P. 1999. *Floriculture and Landscaping*. Naya Prakash. Calcutta.
6. Lauria, A and Victor, H.R. 2001. *Floriculture – Fundamentals and Practices*. Agrobios, Jodhpur
7. Nambisan, K.M.P.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
8. Randhawa, G.S and Mukhopadhyay, A. 1986. *Floriculture in India*. Allied Publ.New Delhi
9. Sabina, G.T and Peter, K.V. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
10. Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.
11. Woodrow MG.1999. *Gardening in India*. Biotech Books.
12. Bose, T.K., Maiti, R.G. and Dhua, R.S. Floriculture & Landscaping. 2010. (2nd Revised Edition) Vol.I &II. Naya Udyog, 206, Bidhan Sarni, Calcutta.

AGENGG 221 Renewable Energy and Green Technology Credit hours: 2(1+1)

Theory

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

Practical

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

1. Rathore, N.S. Panwar N. L and Kurchania A.K .2008. Renewable Energy, Theory and Practices, Himanshu Publication, Udaipur
2. Rathore, N.S. Kurchania K. and Panwar N.L. 2007.Non Conventional Energy Sources, Himanshu Publication, Udaipur
3. कौशिक, एस. सी. एवं पंवार, एन. एल. 2010. वैकल्पिक ऊर्जा संसाधन, हिमांशु पब्लिकेशन्स, उदयपुर
4. Rai, G.D. 2004. Non Conventional Energy Sources, Khana Publisher, New Delhi.

Theory

Quality and health of cultivated soils. Distribution of problem soils in different agro ecosystem of India. Their categorization based on properties. Reclamation and management of problem soils, Acid soils and highly and low permeable soils.

Bio-remediation of problem soils through multipurpose trees (MPTs). Land capability classification, land suitability classification.

Irrigation water – quality and standards. Utilization of poor quality water in agriculture.

Practical's

*Visual diagnosis of problem soils

- Determination of cations (Na^+ , K^+ , Ca^{++} and Mg^{++}) in ground water and soil samples
- Determination of anions (Cl^- , SO_4^{--} , CO_3^{--} and HCO_3^-) in ground waters and soil samples
- Determination of CaCO_3 in calcareous soils
- Lime requirements of acid soil and gypsum requirements of sodic soil.
- Computation of SAR and RSC of irrigation water

Suggested Readings

1. Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
2. Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
3. USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.
4. Abrol, I.P. and Dhurva narayana, V.V. (1998) Technologies for wasteland development, ICAR, New Delhi-110012
5. Cirsan Paul, J.(1985) Principles of remote sensing. Longman, New York.
6. Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. USDA Hand

book No. 60, Washington, DC USA.

7. Somani, L.L. and Totawat, K.L. (1993). Management of salt affected soils and waters.

Agrotech publishing Academy, Udaipur.

8. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). Saline Alkali soils of India, ICAR,

New Delhi.

9. ISSS (2015) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi

HORT 222 Production Technology for Fruit and Plantation Crops Credit hours: 2(1+1)

Theory

Importance and scope of fruit and plantation crop industry in India; High density planting; Use of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, pomegranate, litchi, papaya, apple, pear and peach; minor fruits- Date, ber, aonla, bael, fig, custard apple, pineapple, jackfruit, strawberry, nut crops; plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops including Micro-propagation. Description and identification of fruit. Preparation of plant bio regulators and their uses, Pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchard.

Suggested Readings:

1. Bal, J.S.1999. Fruit Production, Kalyani Publisher, New Delhi.
2. Bose, T.K. Mitra, SK and Sanyal, 2002. Fruit of Indian tropical and sub-tropical (III) revised edition), Naya Udhog-206, Kolkata.
3. Chadha, K.L. 2010. Handbook of Horticulture (New eds.). Indian Council of Agricultural Research, New Delhi
4. Chundawat, B.S and Sen,N.L. 2002. Principle of Fruit culture. Agrotech Publication Academy, Udaipur
5. Shukla, A.K., Kaushik, R.A., Mahawer, L.N., Pareek, S.K., Pandey, D and Sarolia, D.K.2008. Adhunik Phalotapadan (Hindi). Communication Centre, MPUAT Press, Udaipur (Raj.)
6. Child, R. 1966. Coconuts. Longmans, London
7. Hearer, A.E. 1971. Coffee Growing. Oxford University press, London
8. Menon, K.P.V. and Pandlai, K.H. 1957. The Coconut Palms. Indian Central Coconut Committee, Emarkulam, Kerala
9. Nair, M.N.C; Rao Bhaskara; Nambisans, K.K.N. and Nambisan, M.C. 1979. Cashew – A Monograph, CPCRI, Kassargod
10. Polhamus, L.G. 1962. Rubber, Longman, London

Theory

Seed and seed technology: introduction, definition and importance. Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed. Nucleus, Breeder, Foundation and certified seed production of important **cereals** (Rice, Maize, Sorghum, Pearl Millet, Ragi), **pulses** (Urd, Mung, Pigeonpea, Lentil, Gram, Fieldpea), **oilseeds** (Soybean, Rapeseed and Mustard), **fodder** (Oat, Berseem, multicut sorghum) and **vegetables** (okra, reddish and Chille). Seed certification, phases of certification, procedure for seed certification, field inspection. Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Varietal Identification through Grow Out Test and Electrophoresis, Molecular and Biochemical test. Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production.

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

Practical

Seed production in major cereals: Wheat, Rice, Maize, Sorghum and Bajra. Seed production in major pulses: Urd, Mung, Pigeonpea, Lentil, Gram, Fieldpea. Seed production in major oilseeds: Soybean, Rapeseed and Mustard. Seed production in vegetable crops. Seed sampling and testing: Physical purity, moisture%, heterogeneity, RPL, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: moisture %, heterogeneity, RPL, Grow out test and electrophoresis. Seed certification: Procedure, Field inspection, Preparation of field inspection report. Visit to seed production farms, seed testing laboratories and seed processing plant.

Suggested Readings:

- Agarwal, R.L. 2008. Seed Technology. Oxford and IBH Publishing Co., Pvt Ltd New Delhi.
- Agarwal, P.K. 1999. Seed Technology. ICAR, New Delhi.
- Bhojwani, S.S. and Bhatnagar, S.P. 1999. The Embryology of Angiosperm. Vikas Publ.
- Black, M., Bewley, D. and Halmer, P. 2006. The Encyclopedia of Seeds: Science, Technology and Uses. CABI.
- Chhabra, A.K. 2006. Practical Manual of Floral Biology of Crop Plants. Deptt. of Plant Breeding, CCS HAU, Hisar.
- Copeland, L.O. and McDonald, M.B. 2001. Principles of Seed Science and Technology. 4th Ed. Chapman & Hall.
- Khare, D. and Bhale M.S. 2011. Seed Technology. Published by Scientific Publishers, New Delhi.
- Singhal, N.C. 2003. Hybrid Seed Production in Field Crops. Kalyani Publishers

Theory

Farming System-scope, importance, and concept, Types of farming and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system: definition, principles, objectives, scope, components, characteristics and its advantages, Development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment.

Suggested Readings

1. Panda, S.C.2004. Cropping Systems and Farming Systems, Agrobios (India), Jodhpur.
2. Panda, S.C.2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur.
3. Panda, S.C. 2012. A Handbook of Agriculture, Agrobios (India), Jodhpur.
4. Sharma, Arun K. 2002. A Handbook of Organic Farming, Agrobios (India) Ltd., Jodhpur
5. Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (2nd edition), Agrobios (India), Jodhpur.
6. Shukla, Rajeev K. 2004. Sustainable Agriculture, Surbhee Publications, Jaipur
7. Palaniappan, S.P.1985. Cropping Systems in the Tropics: Principles and Management, Wiley Easter Ltd. and TNAU, Coimbatore.
8. Reddy S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
गौतम, आर.सी. एवं सिंह, पंजाब.1997. टिकाउ खेती, भारतीय कृषि अनुसन्धान परिषद, नई दिल्ली.

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; product life cycle (PLC) and competitive strategies: Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits; marketing process and functions: Marketing Management: Segmentation, targeting & positioning. Marketing mix and marketing strategies. 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 labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Role of APMC and its relevance in the present contexts. Concept of e- NAM. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

Practical

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

Suggested readings:

1. Acharya, S.S. and Agarwal, N.L., 1994, Agricultural Price Analysis and Price Policy, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Acharya, S.S. and Agarwal, N.L., 2004, Agricultural Marketing in India, Oxford and IBH Publishing Co. New Delhi.
3. G. L. Meena, S. S. Burark, D. C. Pant and Rajesh Sharma, 2017. Fundamentals of Agribusiness Management, Agrotech Publishing Academy, Udaipur, ISBN: 978-81-8321-418-6. First edition.
4. Kahlon, A.S. and George, M.V., 1985, Agricultural Marketing and Price Policy, Allied Publication Pvt. Ltd., New Delhi.
5. Kohls, Richard L. and Uhl, Joseph N., 1980, Marketing of Agricultural Products, Macmillan Publishing Co., Inc. New York
6. Mamoria, C.B and Joshi, R.L., 1971, Principles and Practice of Marketing in India, Kitabmahal, Allahabad.

Theory

Agro-meteorology- aim, scope and applications; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, 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, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of 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 and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of windrose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET

Suggested Readings

1. Varshneya, M.C. and Balakrishana, Pillai, P.2003. Textbook of Agricultural Meteorology, ICAR, New Delhi
2. Lal, D.S.2005. Climatology, Sharda Pustak Bhawan, Allahbad
3. Sahu, D.D.2017. Agrometeorology and Remote Sensing: Principles and Practices, Agrobios (India), Jodhpur.
4. Panda, S.C.2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
5. Balasubramaniyan, P. and Palaniappan, S.P.2001. Principles and Practices of Agronomy, Agrobios (India), Jodhpur
6. Rao, G.S.L.H.V. Prasad. 2008. Agricultural Meteorology. Prentice-Hall of India Pvt. Ltd, New Delhi.
7. लाल, डी,एस. 2007. जलवायु विज्ञान,शारदा पुस्तक भवन, इलाहबाद
8. पोरवाल, बी. एल., सिंह, पुष्पेन्द्र एवम् शर्मा, डी. डी. 2000. सस्य विज्ञान के मूल तत्व, के. पी. प्रकाशन, उदयपुर

ENTO. 221 MANAGEMENT OF BENEFICIAL INSECTS CREDIT HOURS
2 (1+1)

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. Identification of major parasitoids and predators commonly being used in biological control.

Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. 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 and natural enemies. Identification and techniques for mass multiplication of natural enemies.

Suggested Readings:

Aruga H. 1994. *Principles of Sericulture*. Oxford & IBH, New Delhi.

Atwal AS. 2006. *The World of the Honey Bee*. Kalyani Publ., New Delhi.

Ganga G. 2003. *Comprehensive Sericulture*. Vol. II. *Silkworm Rearing and Silk Reeling*. Oxford & IBH, New Delhi.

Singh S. 1975. *Beekeeping in India*. ICAR, New Delhi.

Theory

Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Weed prevention, control and eradication; Methods of weed control: physical, chemical and biological. Integrated weed management. Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicides and selectivity. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with nutrients and their application. Integration of herbicides with non chemical methods of weed management. Herbicide Resistance and its management. Weed management in important cereals, pulses, oilseeds and commercial crops.

Practical

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

Suggested Readings:

1. Gupta, O.P. 2015. Weed Management: Principles and Practices (3rd edition), Agrobios (India), Jodhpur.
2. Gupta, O.P. 2016. Modern Weed Management (3rd edition), Agrobios (India), Jodhpur.
3. Rao, V.S. 2000. Principles of Weed Science (2nd edition), Oxford and IBH Publishing Co., New Delhi.
4. Saraswat, V.N., Bhan, V.M. and Yaduraju, N.T. 2003. Weed Management, ICAR, New Delhi.
5. तिवारी, जे. पी. 2007 नींदा (खरपतवार) नियंत्रण विज्ञान, साइंटिफिक पब्लिशर्स, जोधपुर

Theory

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

Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of *Trichoderma*, *Pseudomonas*, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management.

Suggested Readings

1. David, B.V. 2000. Elements of Entomology. CAB Publications, Chennai.
2. Dhaliwal, G.S. and E.A. Heinrichs. 1998. Critical issues in pest management. Commonwealth Publishers, New Delhi. 287 p.
3. Dhaliwal, G.S. and Ramesh Arora 2002. Integrated Pest Management – Concept and Approaches. Kalyani Publishers, New Delhi, 297 p.
4. Pradhan, S. 1983. Agricultural Entomology and Pest Control. Indian Council of Agricultural Research, New Delhi, 267 p.
5. Pedigo, L.P. 2002. Entomology and Pest Management. Prentice hall of India, New Delhi.
6. Metcalf, R.L. and Luckmann, W.H. 1982. Introduction of Insect Pest Management. A Wiley – Interscience Publication, 561 p.
7. Gupta VK & Sharma RC. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.
8. Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. Biotechnological Approaches for the Integrated Management of Crop Diseases. Daya Publ. House, New Delhi.

9. Sharma, R.C. and Sharma J.N. (Eds). 1995. Integrated Plant Disease Management. Scientific Publ., Jodhpur.
10. Singh, R. S. 2001. Plant disease management. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Soil organic matter , composition, properties and influences of soil fertility, Humic substances – nature and properties.

Chemical fertilizers: classification, specification and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order.

History of soil fertility and plant nutrition. criteria of essentiality. Forms of nutrients in soil, role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), Integrated nutrient management.

Practical

Introduction of analytical instruments and their principles, Estimation of soil organic carbon, Estimation of available N in soils. Estimation of soil extractable P in soils. Estimation of exchangeable K; Ca and Mg in soils . Estimation of soil extractable S in soils.. Estimation of DTPA extractable Zn in soils. Estimation of N in plants. Estimation of P in plants. Estimation of K in plants. Estimation of S in plants.

Suggested Readings:

1. Biswas, T.D. and Mukherjee, S.K. (2006) Text book of soil science. Tata McGraw Hill publishing Co. Ltd, New Delhi
2. Das, D.K. (2002) Introductory Soil Science, Kalyani publisher, New Delhi
3. Rai, M.M. (2002) Principal of Soil Science, Mac Millan India Ltd, New Delhi
4. Mehra R.K. (2004) Text book of Soil Science, ICAR New Delhi
5. ISSS (2002) Fundamental of Soil Science Div. of Soil Science, IARI, New Delhi

6. Jackson, M.L. (1973) Soil chemical analysis, Prentice Hall of India, Pvt. Ltd New Delhi
7. Piper, C.S. (1950) Soil and Plant analysis, .Hans publications, Bombay
8. Singh Dhyani, Chhonkar,P.K. and Dwivedi V.S. (2005) Manul on Soil Plant and water analysis. Westville Publishing House, New Delhi
9. Tisdale,S.L. Nelson, W.L. Beaton, J.D. and Havlin, J.L.(1991) Soil fertility and fertilizers (5th ed.).Prentice Hall of India, Pvt .Ltd, New Delhi.
10. Singh Vinay (1996) (Hindi) Soil Science, fertilizer & Manures , V.K. Prakashan Barot Merrut (U.P)
11. Yawalkar, K.S. and Agarwal. J.P. (1992). Manure and fertilizers. Agriculture-Horticulture Publishing House, Nagpur.
12. Sanchalli, V.K. (1960). Chemistry and Technology of Fertilizers. Reinhebl publishing corporation, New York,USA.
13. Chopra, S.L. and Kanwar, J.S. (1991). Analytical Agriculture, Chemistry, Kalyani Publishers, New Delhi.
14. Tandon, H.L.S. (1989). Soil water and fertilizers analysis, Fertilizer Development and Consultant organization, New Delhi
15. FAI. (1999). Fertilizer (Control) Order, 1985 and the essential commodities Act, 1995. FAI, New Delhi, pp. 203.
16. Kanwar, J.S. (1976). Soil Fertility: theory and practice. (ed) ICAR, New Delhi pp. 583.
17. McVicker, M.H. (1952). Using commercial fertilizers, Interstate Danvilk, US.

**ENTO 311 PESTS OF KHARIF CROPS, THEIR
MANAGEMENT AND IPM CONCEPT**

Credit hours:2(1+1)

Theory:

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, nature of damage, and management of major pests of various field crop, vegetable crop, fruit crop, plantation crops, ornamental crops, spices and condiments during *kharif*.

Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control-importance, hazards and limitations. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation. Insecticides Act 1968-Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes.

Practical:

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; (d) Spices & condiments during *kharif*. Assessment of losses due to insects. Calculations on the doses of insecticide application technique.

Suggested Readings:

1. David BV and Ramamurthy VV. 2016. *Elements of Economic Entomology*. 8th Edn. Brillion Publ., New Delhi.
2. Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
3. Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi
4. Evans JW. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.
5. Nair MRGK. 1986. *Insect and Mites of Crops in India*. ICAR, New Delhi.
6. Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management*. Kalyani Publ., New Delhi.
7. Pedigo LP. 2008. *Entomology and Pest Management*. Phi Learning Publisher.

PPATH-312 Diseases of Field, Horticultural Crops & their Management-I Cr. Hr.3(2+1)

Theory

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

Field Crops: **Rice:** blast, bacterial blight, sheath blight, khaira and tungro; **Maize:** stalk rots, downy mildew, leaf spots; **Sorghum:** smuts, and anthracnose, **Bajra :**downy mildew, ergot and smut. **Groundnut:** early and late leaf spots, collar rot. **Soybean:** Rhizoctonia root rot, bacterial spot and mosaic; **Pigeonpea:** wilt and sterility mosaic; Black & green gram: Cercospora leaf spot, anthracnose and yellow mosaic; **Castor:** Bacterial blight and wilt; **Tobacco:** mosaic. **Sesame:** phyllody and bacterial spot, Cluster bean: Bacterial leaf blight, Powdery mildew and Alternaria blight, Cotton: Vascular wilt and black arm.

Horticultural Crops: **Guava:** wilt and anthracnose; **Banana:** Panama wilt, bacterial wilt and bunchy top; **Papaya:** Foot rot, leaf curl and ring spot; **Pomegranate:** bacterial blight and Aspergillus rot ;**Brinjal:** Phomopsis blight and little leaf. **Tomato:** damping off, bacterial wilt, early blight, and leaf curl; **Okra:**Yellow Vein Mosaic and Powdery mildew; Ginger: Rhizome rot; **Ber:** Powdery mildew, **Aonla** rust, **Custard** apple: Leaf spots.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Note: Students should submit 30 pressed and well-mounted specimens.

Suggested Readings

1. Singh, R.S. Diseases of fruit crops: Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
2. Cook, A.A. 1981 Diseases of tropical and sub-tropical field, fiber and oil plants: Mac Millan Publishing Co., New York.
3. Rangaswamy, G. and Mahadevan, A. 2001. Diseases of Crop Plants in India: Prentice Hall of India Pvt. Ltd., New Delhi.
4. Sohi, H.S. 1992. Diseases of Ornamental Plants in India. ICAR, New Delhi
5. Singh, R.S. 1998. Plant Diseases: Oxford & IBH publishing Co.,Pvt.Ltd.,New Delhi.
6. Cook, A.A. 1981. Diseases of tropical and sub-tropical field, fiber and oil plants: Mac Millan Publishing Co., New York.
7. Rangaswamy, G and Mahadevan, A. 2001. Diseases of Crop Plants in India: Prentice Hall of India Pvt. Ltd., New Delhi.
8. Gupta, V.K. and Paul, Y.S. (eds.) 2002. Diseases of Field Crops, Indus Publishing Co., New Delhi.
9. Agrios,G.N. 2005 . Plant Pathology: Elsevier Academic Press, New York.

Theory

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

Practical

Emasculation and hybridization techniques in different crop species; viz., Rice, Maize, Sorghum, Pearl Millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Sesame, Caster, Cotton, Cowpea, Pearl millet, Brinjal and Tomato. 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 seeds production in *Kharif* crops; Estimation of variability parameters, heterosis, inbreeding depression and heritability; Layout of field experiments; RBD and Augmented design Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

Suggested Readings:

- Bahl, P.N. and Salimath, P.M. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol 1 Pulses and Oilseeds. Oxford & IBH Publishing Co Pvt Ltd, New Delhi.
- Chopra, V. L., 2001. Breeding Field Crops. Oxford IBH publication, New Delhi.
- Gill, K.S. 1991. Pearl Millet and its Improvement. Indian Council of Agricultural Research, New Delhi.
- IRRI. 2000. Rice Genetics IV. Proceedings of the International Rice Genetics Symposium, Philippines.
- Jennings, P.R., Coffman, W.R. and Kauffman, H.E. 1979. Rice Improvement. IRRI, Philippines. 186p.
- Kumar, N. 2006. Breeding of Horticultural Crops –Principles and Practices. New India Publishing Agency, New Delhi
- Murty, D.S., Tabo, R. and Ajayi, O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru
- Nanda, J.S. 1997. Manual on Rice Breeding, Kalyani Publishers, Ludhiana. 120p.
- Poehlman, J.M. and Borthakur, D. 1995. Breeding Asian Field Crops . Oxford and IBH Publishing Co., New Delhi
- Ram, H. H. 2006. Crop Breeding & Genetics. Kalyani Publishers, Ludhiana
- Singh, H.G., Mishra, S.N., Singh, T.B., Ram, H.H. and Singh, D.P. (Eds). 1994. Crop Breeding in India. International Book Distributing Co. Chandigarh.

EXT-311 Entrepreneurship Development and Business Communication 2 (1+1)

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy, programs and institutions for entrepreneurship development, Impact of economic reforms on Agri-business/ Agri-enterprises, Entrepreneurship development Process; Business Leadership Skills; Organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Managerial skills, Business Leadership Skills (Communication, direction and motivational Skills), Problem solving skill, Supply chain management and Total quality management, Project Planning, Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, Practicing problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institutes and interaction with entrepreneurs.

Suggested Readings:

Akhouri, M.M.P., Mishra, S.P. and Sen Gupta, R.1989. Trainers Manual on Developing Entrepreneurial Motivation. NIESBUD, New Delhi.

Bidgoli, H.1989. Decision Support Systems: Principles and Practices. St.Paul, West Publishing Co.,USA.

Bhaskaran, S. 2014. Entrepreneurship Development and Management. Aman Publishing House, Meerut.

Goyal, D.P.1994. Management Information System: Concept and Application. Deep & Deep Publisher, New Delhi.

Mancuso, J.1974. The Entrepreneurs Handbook (Vol.192). Artech House, Inc., USA.

Patel, V.G.1987. Entrepreneurship Development Programme in India and Its Relevance to Developing Countries. Entrepreneurship Development Institute of India, Ahmedabad.

Rao, T.V.1974. Development of an Entrepreneur. Indian Institute of Management, Ahmedabad.

Theory

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

Practical

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

Suggested Readings

1. Krishna, K.K. 2013. Precision Farming: Soil Fertility and Productivity Aspects. Apple Academic Press.
2. Srivastava, G.S. 2014. An Introduction to Geoinformatics. McGrew Hill Education (India) Pvt. Ltd. , New Delhi.
3. Gupta, R.K. and Subhash Chander. 2008. Principles of Geoinformatics. Jain Brothers, New Delhi.
4. Choudhary, S. 2011. Applied Nanotechnology in Agriculture. Arise Publishers & Distributors.
5. Sekhon, B.S. 2014. Nanotechnology in agri-food production: an overview. *Nanotechnology, Science and Applications* 7:31-532.

AGRON-312

Practical Crop Production-I (*Kharif Crops*)

Credit hours 2(0+2)

Practical

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

Suggested Readings

1. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2008. Manures and Fertilizers (10th edition), Agri-Horticultural Publishing House, Nagpur.
2. Balasubramaniyan, P. and Palaniappan, S.P. 2001. Principles and Practices of Agronomy Agrobios (India), Jodhpur.
3. Reddy, S. R., 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
4. Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

PBG-312 Intellectual Property Rights

Credit hours: 1(1+0)

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.

Types of Intellectual Property and legislations covering IPR in India:-Patents, Copyrights,

Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database.

Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders.

Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

Reference Books:

1. IPR & Plant Breeder's Rights At a glance - Phundan Singh & Rajeev Singh
2. IPR & Plant Breeder's Rights- Phundan Singh
3. IPR & Plant Breeder's Rights- Phundan Singh, Rajeev Singh ,S.K. Chandel & S.K. Chauhan

Theory

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

Practical

Collection and preparation agricultural waste sample. Determination of pH, EC, CECe, heavy metals, BOD, COD, TSS, TDS, NH₄, Total P, and dissolved reactive P. Nutrient status (N, P, K, secondary and micronutrients) analysis of agricultural waste. Waste management equipment operation, Maintenance and safety hazards, computer software and models. Survey of different agri waste from live stock, dairy, poultry, food processing, fruit & vegetable and agri-chemicals, Preparation of compost, Vermicomposting, biogas and analysis of compost.

Suggested Readings

1. Sannigrahi, A.K. 2011. Agriculture and Waste Management for Future Sustainable Future, New India Publishing Agency, New Delhi.
2. Loehr, R.C. 2012. Agricultural Waste Management: Problems, Processes, and Approaches, Academic Press Inc..
3. NAAS. 2010. "Agricultural Waste Management" Policy Paper 49, National Academy of Agricultural Sciences, New Delhi.
4. Sanjay Kumar. 2013. Fundamentals of Renewal Energy Resources and Technology. Kalyani Publishers, New Delhi.
5. Panda, H. 2013. The Complete Book on Biological Waste Treatment and their Utilization, NIIR Project Consultancy Services, New Delhi.
6. IARI. 2012. Crop residues management with conservation agriculture: Potential, constraints and policy needs. Indian Agricultural Research Institute, New Delhi.

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2×2 Contingency Table. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2×2 contingency table. Selection of random sample using Simple Random Sampling.

Suggested Reading:

1. S.R.S. Chandel (2003). Hand Book of Agricultural Statistics. Achal Prakashan Mandir, Kanpur.
2. S.C. Gupta (2006). Fundamentals of Statistics. Himalaya Publishing House, New Delhi.
3. R. Rangaswami (2006). A Text Book of Agricultural Statistics. New Age International Publishers Ltd., New Delhi.
4. G. N. Rao (2012). Statistics for Agricultural Science, OXFORD & IBH publishing House New Delhi.

AGENGG-321 Protected Cultivation and Secondary Agriculture Credit hours: 2(1+1)

Theory

Green house technology: Introduction, Types of Green Houses; Planning and design of greenhouses, Design criteria of green house for cooling purposes. Green house equipments, materials of construction for traditional and low cost green houses, irrigation systems used in greenhouses.

Introduction of engineering properties such as physical, thermal and aero-dynamic properties of cereals, pulses and oilseed, Introduction to various cleaning, grading and sorting equipments for cereals, pulses and oilseed, Introduction to different milling process of cereals, pulses and oilseed, Drying and dehydration; moisture measurement, various drying method, various grain dryers such as flat bed dryer, mechanical tray dryer and solar cabinet dryer.

Practical

Study of different type of green houses based on shape. Study of green house equipments. Study of various cleaners, graders. Study of various size reduction equipments such as burr mill, hammer mill and grinder. Determination of Moisture content of various grains by oven drying. Determination of engineering properties such as shape and size, bulk density and porosity of biomaterials. Determination of Moisture content of various grains by moisture meter. Visit of seed processing plant.

Suggested Readings

1. Singh, K K and Sahay, K.M. 2000. Unit Operations in Agricultural Processing. Vikas Publishing House, New Delhi.
2. Chakravorty, A. and De, D.E. 1998. Post Harvest Technology of Cereal and Pulses. Oxford & ISH Publishing Co. Pvt. Ltd., New Delhi.

PPATH-321 Diseases of Field, Horticultural Crops & their Management-II Cr.Hr.3(2+1)

Theory

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

Field Crops:

Wheat: rusts, smuts, bunts and powdery mildew. **Mustard:** white rust, downy mildew and Sclerotinia stem rot; **Gram:** Wilt and Ascochyta blight; **Pea:** Powdery mildew and rust **Sugarcane:** red rot and smut. **Cumin:** Blight, wilt and powdery mildew; **Opium:** Downy mildew and Bacterial leaf blight.

Horticultural Crops: **Cruciferous vegetables:** Alternaria blight and black rot **Mango:** Anthracnose, malformation and powdery mildew; **Citrus:** Canker and gummosis; **Grape vine:** Downy mildew, Powdery mildew and anthracnose; **Potato:** Early and late blight and leaf roll. **Cucurbits:** Downy mildew, powdery mildew. **Onion:** Purple blotch. **Chillies:** Anthracnose and fruit rot, Rhizoctonia root rot and leaf curl; **Turmeric:** Taphrina leaf spot **Coriander:** Stem gall **Rose:** Dieback and powdery mildew.

Practical

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

Note: Students should submit 30 pressed and well-mounted specimens.

Suggested Readings

1. Singh, R.S. 2000. Diseases of fruit crops: Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
2. Cook, A.A. 1981 Diseases of tropical and sub-tropical field, fiber and oil plants: Mac Millan Publishing Co., New York.
3. Rangaswamy, G. and Mahadevan, A. 2001. Diseases of Crop Plants in India: Prentice Hall of India Pvt. Ltd., New Delhi.
4. Sohi, H.S. 1992. Diseases of Ornamental Plants in India. ICAR, New Delhi
5. Singh, R.S. 1998. Plant Diseases: Oxford & IBH publishing Co., Pvt. Ltd., New Delhi.
6. Gupta, V.K. and Paul, Y.S. (eds.) 2002. Diseases of Field Crops, Indus Publishing Co., New Delhi.
7. Agrios, G.N. 2005. Plant Pathology: Elsevier Academic Press, New York.

HORT 321 Post-harvest Management and Value Addition of Fruits and Vegetables Credit hours: 2(1+1)

Theory

Importance of fruits and vegetables, extent and possible causes of post harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Role of ethylene; Post harvest disease and disorders; Heat, chilling and freezing injury; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Tomato products- Concepts and Standards; Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning - – Concepts and Standards, packaging of products.

Practical

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

Suggested Readings:

1. Chadha, K.L. and Pareek, O.P. 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House. New Delhi.
2. Haid, N.F and Salunkhe, S.K. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.
3. Mitra, S.K. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.
4. Ranganna, S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
5. Sudheer, K.P & Indira, V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
6. Willis, R., Mc Glassen, W.B., Graham, D. and Joyce, D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.
7. Lal, G., Siddappa, G.S. and Tandon, G.L. 1967. *Fruit and Vegetable preservation*. ICAR publication, New Delhi.
8. Cruess, W.V. 1958. *Commercial Fruit and Vegetable Products*. Mc Grew-Hill Book Co. Inc., New York
9. Sharma, S.K. 2010. *Post-harvest Management and Processing of Fruits & Vegetables: Instant Notes*. New India Publishing Agency, New Delhi.

10. Rajarathnam, S. 2011. *Advances in Preservation and Processing Technologies of Fruits & Vegetables*. New India Publishing Agency, New Delhi.

ENTO 321 PESTS OF RABI CROPS, STORED PRODUCE AND THEIR MANAGEMENT Cr. Hrs. 2(1+1)

Theory:

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, nature of damage, and management of major pests of various field crop, vegetable crop, fruit crop, plantation crops, ornamental crops, spices and condiments during rabi.

Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical:

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; (d) Plantation, Narcotics, spices & condiments during rabi. Identification of insect pests and mites associated with stored grain. Determination of insect infestation by different methods. Fumigation of grain store/godown. Identification of rodents and rodent control operations in godowns. Identification of birds and bird control operations in godowns. Methods of grain sampling under storage condition.

Suggested Readings:

1. Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management*. Kalyani Publ., New Delhi.
2. Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essential of Agricultural Entomology*. Kalyani Publ., New Delhi.
3. David BV and Ramamurthy VV. 2016. *Elements of Economic Entomology*. Brillion Publ., New Delhi.
4. Khare BP. 1994. *Stored Grain Pests and Their Management*. Kalyani Publ., New Delhi.
5. Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products*. Marcel Dekker, New York.
6. Prakash I & Mathur RP. 1987. *Management of Rodent Pests*. ICAR, New Delhi.
7. David Rees 2004. *Insect pests of stored products*. CSIRO Publ., Australia.

Theory

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

Practical

Emasculation and hybridization techniques in different crop species namely Wheat, Oat, Barley, Chickpea, Lentil, Field pea, Rapeseed Mustard, Sunflower, Potato, Berseem. Sugarcane, Cowpea; 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 seeds production in *Rabi* crops; Estimation of variability parameters, heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

Suggested Readings:

- Bahl, P.N. and Salimath, P.M. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol 1 Pulses and Oilseeds. Oxford & IBH Publishing Co Pvt Ltd, New Delhi.
- Chopra, V. L., 2001. Breeding Field Crops. Oxford IBH publication, New Delhi.
- Gill, K.S. 1991. Pearl Millet and its Improvement. Indian Council of Agricultural Research, New Delhi.
- IRRI. 2000. Rice Genetics IV. Proceedings of the International Rice Genetics Symposium, Philippines.
- Jennings, P.R., Coffman, W.R. and Kauffman, H.E. 1979. Rice Improvement. IRRI, Philippines. 186p.
- Kumar, N. 2006. Breeding of Horticultural Crops –Principles and Practices. New India Publishing Agency, New Delhi
- Murty, D.S., Tabo, R. and Ajayi, O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru
- Nanda, J.S. 1997. Manual on Rice Breeding, Kalyani Publishers, Ludhiana. 120p.
- Poehlman, J.M. and Borthakur, D. 1995. Breeding Asian Field Crops . Oxford and IBH Publishing Co., New Delhi
- Ram, H. H. 2006. Crop Breeding & Genetics. Kalyani Publishers, Ludhiana
- Singh, H.G., Mishra, S.N., Singh, T.B., Ram, H.H. and Singh, D.P. (Eds). 1994. Crop Breeding in India. International Book Distributing Co. Chandigarh.

Practical

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

Suggested Readings

1. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2008. Manures and Fertilizers (10th edition), Agri-Horticultural Publishing House, Nagpur.
2. Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (2nd edition), Agrobios (India), Jodhpur.
3. Reddy, S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
4. Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

Theory

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

Practical

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

Suggested Readings

1. Dhama, A.K. 2014. Organic Farming for Sustainable Agriculture (2nd edition), Agrobios (India), Jodhpur.
2. Sharma, Arun K. 2013. A Handbook of Organic Farming, Agrobios (India), Jodhpur
3. Palaniappan, S.P. and Anandurai, K.1999. Organic Farming – Theory and Practice. Scientific Pub. Jodhpur
4. Thapa, U and Tripathy, P. 2006. Organic Farming in India, Problems and prospects, Agritech, Publising Academy, Udaipur.
5. शर्मा, अरुण के. 2015. जैविक खेती – नई दिशाए, एग्रोबायोस (इण्डिया), जोधपुर

AGECON-321 Farm Management, Production and Resource Economics

Credit hours: 2(1+1)

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms. concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, Principles of farm management: law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labor income and farm business income. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting. Concepts of natural resource economics, types of natural resource and management of common property resources.

Practical

Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts.

Suggested reading:

1. Dhondyal, S.P., "Farm Management – An Economic Analysis", Aman Publishing House, Madhu Market, Meerut (U.P.).
2. I. Bhavani Devi,P. Raghu Ram,S. Subba Reddy,T.V. Neelakanta Sastry, 2009, Agricultural economics, Oxford and IBH Co. Pvt. Ltd., , New Delhi.
3. Johl, S.S. and T.R. Kapur, 1989, Fundamentals of Farm Business Management, Kalyani Publishers, Ludhiyana.
4. Kerr, John M., et al., 1997, Natural Resource Economics: Theory and Applications in India, Oxford & IBH, New Delhi.
5. Raju, V. T. and D. V. S. Rao, 2002, "Economics of Farm Production and Management", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Sankhayan, P. L., 1988, Introduction to the Economics and Agricultural Production, Prentice Hall of India Private Limited, New Delhi.
7. Singh, I. J., 1977, Elements of Farm Management Economics, Affiliated East-West Press Pvt. Ltd., New Delhi.

Theory :-

History and economic importance of nematodes; characters of phylum Nematoda, systematic position of nematodes in animal kingdom; general morphology and biology of nematodes; plant nematode relationship ; nematode ecology and disease complexes. Nematode diseases of crop plants of economic importance with special reference to *Meloidogyne*, *Heterodera*, *Globodera*, *Pratylenchus*, *Radopholus*, *Rotylenchulus*, *Tylenchulus*, *Anguina*, *Aphelenchoides*. Principles of nematode management, Integrated pest management.

Practical :-

Collection of soil and plant samples, extraction of nematodes from soil and roots. Preparation of temporary mounts of nematodes; staining and separation of nematodes in plant tissues ; study of nematode disease diagnosis in cereal, pulse, fiber, oilseed, vegetable, fruit, ornamental crops and protected cultivation systems ; identification of important plant parasitic nematodes.

Suggested Reading:

1. Walia, R.K. and Bajaj , H.K . (2014). Text book on Introductory Plant Nematology (IInd edition). ICAR, New Delhi .
2. Reddy, P.P. (1993). A Treatise on Phytonematology. Agricole Publishing Academy, New Delhi.
3. बी. एस. यादव और ए. के. पाठक, (1997). सूत्रकृमी और उनका नियंत्रण. भारतीय कृषि अनुसंधान परिषद , नई दिल्ली.
4. सुशील कुमार एवं बी. पी. सिंह, (1992). पादप सूत्रकृमी विज्ञान (द्वितीय संस्करण) , रामा पब्लिशिंग हाउस, मेरठ (उ.प्र.).

Theory

Importance of water in plants; Irrigation: definition and objectives; Water resources in India and Rajasthan; Forms of soil water and soil moisture constants; Methods of soil moisture determination, evapotranspiration and crop water requirement; Scheduling of irrigation; Methods of irrigation: surface, sprinkler and drip irrigation; Irrigation efficiency and water use efficiency; Irrigation water quality and its management; Conjunctive use of water; Water management of different crops *viz.* rice, wheat, maize, sugarcane, and important pulses and oilseed crops; Agricultural drainage.

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 through flumes and weirs; Calculation of irrigation water requirement (Problems); Demonstration of irrigation methods *viz.* surface, sprinkler and drip methods; Calculation of irrigation efficiency; Visit to farmers field and cost estimation of drip irrigation system; Determination of EC, pH, and $\text{Ca}^{++} + \text{Mg}^{++}$ of irrigation water

Suggested Readings:

1. Lenka, D. 1999 Irrigation and Drainage. Kalyani Publishers. L.D.H., New Delhi.
2. Michael, A.M. 1987. Irrigation: Theory and Practice. Vikas Publishing House, New Delhi.
3. Mishra, R.D. and Ahmed, M.1987 Manual on Irrigation Agronomy. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Parihar, S.S. and Sandhu, B.S. 1987 Irrigation of Field Crops – Principles and Practices. ICAR, New Delhi.
5. Reddy, S.R. 2007. Irrigation Agronomy. Kalyani Pub. , New Delhi.
6. Reddy, G. H. S. and Reddy, T. Y. 2003 Efficient use of Irrigation Water. Kalyani Pub. , New Delhi.
7. Panda, S. C. 2003. Principles and Practices of Water Management. Agrobios.