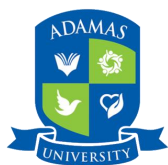


Program Name: B.Sc. (Hons) Agriculture

Code: AGR3401

Offered by the School of Smart Agriculture, Adamas University

Duration: 4 Years



**DETAILED SYLLABUS OF
FOUR YEAR B.Sc. (Hons.) Agriculture Program
SEMESTER I**

Course outcomes: BSc. (Hons.) Agriculture

Year-I, Semester -I

1. AGR11001: Agricultural Heritage (L-T-P :1-0-0) Credit: 1(1-0-0)

CO.1. Understand the relevance of agricultural heritage in modern agriculture.

CO.2. Understand the future scopes of agriculture and allied sciences.

CO.3. Develop the skills pertaining to the different philosophical and technical difference between historical and scientific agriculture

CO.4. Develop evaluative thinking on ancient agricultural facts and information at an Indian perspective.

CO.5. To motivate the students for estimating a balanced view about agricultural heritage vis-à-vis that of the present-day agriculture.

Course content

Unit 1: Introduction of Indian agricultural heritage; Ancient agricultural practices, Relevance of heritage to present day agriculture

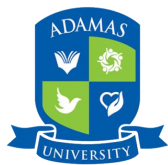
Unit 2: Past and present status of agriculture and farmers in society; Journey of Indian agriculture and its development from past to modern era; Plant production and protection through indigenous traditional knowledge; Crop voyage in India and world

Unit 3: Agriculture scope; Importance of agriculture and agricultural resources available in India; Crop significance and classifications

Unit 4: National agriculture setup in India; Current scenario of Indian agriculture; Indian agricultural concerns and future prospects.

Suggested Readings:

- Reddy Yellamanda T and Shankar Reddy G H. 2017. Principles of Agronomy. Kalyani Publishers Ludhiana.
- Gupta O P. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrows Printers and Publishers. New Delhi.
- Arnon L.. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.
- Yawalkar K S and Agarwal J P. New Eds Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.



2. AGR13002: Fundamentals of Agronomy (L-T-P :2-0-1) Credit : 3(2-0-1)

- CO 1. Different agricultural zones of India, types of soil and crops cultivated in different zones of India
- CO 2. Understand the importance of agronomy and also the different agri inputs, agricultural tools/equipment's, horticultural crops; use of different tillage equipment's.
- CO 3. Identify the different sowing, irrigation, intercropping and harvesting methods.
- CO 4. Understand the different methods of irrigation.
- CO 4. Understand the different cropping system and cropping patterns
- CO 5. Understand the concepts and principles of eco-friendly agriculture.

Course content

Theory

Unit 1: 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

Unit 2: Irrigation- scheduling criteria and methods, quality of irrigation water, logging. Weeds- importance, classification, crop weed competition, concepts of weed management- principles and methods, Herbicides- classification, selectivity and resistance, allelopathy

Unit 3: Growth and development of crops, Difference between growth and Development, factors affecting growth and development, plant ideotypes

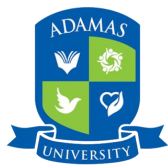
Unit 4: Crop rotation and its principles, adaptation and distribution of crops, Crop management technologies in problematic areas, harvesting and threshing of crops

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, study of agro-climatic zones of India, 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:

- Reddy Yellamanda T and Shankar Reddy G H. New Edn. Principles of Agronomy. Kalyani Publishers Ludhiana.
- Gupta O P. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.
- Arnon L. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.
- Yawalkar K S and Agarwal J P. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
- Balasubramanian P & Palaniappan SP. 2015. Principles and Practices of Agronomy. Agrobios
- Reddy SR. Principles of Agronomy. Kalyani Publishers.



3. AGR13003: Fundamentals of Soil Science (L-T-P :2-0-1) Credit: 3(2-0-1)

- Co.1 Familiarize the students with different concepts of soil, classification and soil of India.
- Co. 2 Understand the process of soil formation, different types of soil forming process soil organisms, organic matter and soil pollution.
- Co. 3 Develop the skills of soil sampling techniques and sampling tools
- Co. 4 To develop the ability to access the soil density, moisture content, texture, porosity, EC, cation exchange capacity and organic matter content of soil

Course content

Theory

Unit 1: 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

Unit 2: 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

Unit 3: Soil water retention, movement and availability; Soil air, composition, gaseous exchange, problem and plant growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability

Unit 4: 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

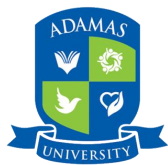
Unit 5: Humic substances - nature and properties; soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

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:

- Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi
- Hillel D. 1982. Introduction to Soil Physics. Academic Press, London
- Brady Nyle C and Ray R Well, 2014. Nature and properties of soils. Pearson Education Inc., New Delhi
- Das DK. 2011. Introductory Soil Science. Third Revised Edition, Kalyani Publishers.
- OpenAccessBooks-SoilScience|InTechOpen <https://www.intechopen.com/books/subject/soil-science/books/all/1/list>



4. AGR13004: Fundamentals of Plant Biochemistry (L-T-P :2-0-1) Credit: 3(2-0-1)

- CO 1. To understand the outlines of bio-molecules, metabolic pathways, morphology and anatomy of plant cells.
- CO 2. Develop the understanding of energy synthesis, enzymatic reactions, cellular function and growth, molecular mechanisms, etc.
- CO 3. Develop the skills for applying principles and methods biochemistry to understand plant growth and metabolisms.
- CO 4. Develop the ability to apply advance techniques for standardization of biochemical processes in plants, optimize cell and tissue growth and culture plant cell and tissue in the laboratory.

Course content

Theory

Unit 1. 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 Poly saccharides.

Unit 2. 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.

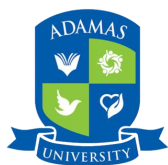
Unit 3. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Unit 4. 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;

Unit 5 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. Micropropagation, hardening and acclimatization. Demonstration on isolation of DNA. Demonstration of gel electrophoresis techniques and DNA finger printing.



Suggested Readings:

- Rajan Katoch (2018) Fundamentals of Plant Biochemistry and Biotechnology, Kalyani Publishers
- Goodwin, TW & Mercer EI. Latest Ed. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. Pergaman Press
- Berg JM, Tymoczko JL, & Stryer L. Biochemistry. 5th Ed. W.H. Freeman & Co.
- Com EE & Stumpf PK. 2010. Outlines of Biochemistry. John Wiley Publications.

5. AGR13005: Fundamentals of Horticulture (L-T-P :1-0-1) Credit: 2(1-0-1)

- CO 1. To describe about the concepts of horticulture; importance and scope, botanical classification of horticultural crops; agroclimatic adaptations, and propagation methods of different horticultural crops etc.
- CO 2. Describe the various principles and methods of training and pruning, kitchen gardening, basic principles of orchard establishment, unfruitfulness etc.
- CO 3. By the end of this course students will be able to critically evaluate the information related to horticulture as being scientifically based or opinion based and contribute to the knowledge based information.
- CO 4. The students will be able to analyse the various problems associated with different horticultural crops and the methods to overcome the same.

Course content

Theory

Unit 1: Horticulture - Its definition and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops

Unit 2: Plant propagation-methods and propagating structures; Seed dormancy, Seed germination, principles of orchard establishment; Principles and methods of training and pruning

Unit 3: Juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy, Vegetative parthenocarpy

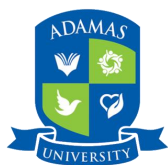
Unit 4: Medicinal and aromatic plants; importance of plant bio-regulators in horticulture. Irrigation – methods, Fertilizer application in horticultural crops

Practical:

Identification of garden tools. Identification of horticultural crops. Preparation of seed bed/ nursery bed. Practice of sexual and asexual methods of propagation including micro-propagation. Layout and planting of orchard. Training and pruning of fruit trees. Preparation of potting mixture. Fertilizer application in different crops. Visits to commercial nurseries/orchard.

Suggested Reading:

- Prasad and Kumar, 2014. Principles of Horticulture 2nd Edn. Agrobios (India).
- Neeraj Pratap Singh, 2005. Basic concepts of Fruit Science 1st Edn. IBDC Publishers.
- Gardner/Bardford/Hooker, J.R.. Fundamentals of Fruit Production. Mac Graw Hill Book Co., New York.



- Edmond, J.B, Sen, T.L, Andrews, F.S and Halfacre R.G. New Edition Fundamentals of Horticulture. Tata Mc Graw Hill Publishing Co., New Delhi
- Kumar, N., 1990. Introduction to Horticulture. Rajyalakshmi publications, Nagarcovil, Tamilnadu
- Jitendra Singh, Latest Edition. Basic Horticulture. Kalyani Publishers, Hyderabad.
- Chadha, K.L.(ICAR), Handbook of Horticulture. ICAR, New Delhi
- Kausal Kumar Misra and Rajesh Kumar, 2014. Fundamentals of Horticulture. Biotech Book

6. AGR13006: Introduction to Forestry (L-T-P :1-0-1) Credit: 2(1-0-1)

- CO 1. The students will be able to understand the classification of forests and methods of their regeneration, forest mensuration, factors affecting standing trees in forest and plantations; salient features of Indian Forest Policies, forest management, forest resources and produce, forest cover in India and in different states.
- CO 2. Develop the understanding of methods used in forest regeneration, recreation, nursery and forest management, silvicultural practices, collecting of non-timber forest products, etc.
- CO 3. Develop the skills in nursery preparation of forest trees, tending operations, forest mensuration, selection of trees in agro-forestry etc.
- CO 4. Develop the ability to measure plant and tree growth, volume of felled and standing trees, age of trees, natural and artificial regeneration, basal cover of forests, etc.

Course content

Theory

Unit 1: 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

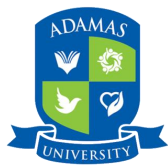
Unit 2. Crown classification. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning. Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement

Unit 3. 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

Unit 4. 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:

- Beazley, M. Latest Edn. The International Book of Forest. London
- Khanna, L.S. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi.
- Persson, R. World Forest Resources. Periodical Experts, New Delhi
- Champion, H, G and Seth, S.K. Forest types of India, a revised survey of forest types of India, GOI Press, New Delhi, 404p.
- Westoby, J. Introduction to World Forestry. Wiley, 240p.
- <https://icar.org.in/files/mFort.pdf>

7. AGR11007: Rural Sociology and Educational Psychology (L-T-P: 2-0-1) Credit: 2(2-0-0)

- CO 1. After completing of the course the students will be able to acquaint the knowledge on various aspects related to rural society, their nature and structure of social stratification, social institutions, cultural concept, meaning and significance of agricultural extension and social groups.
- CO 2. Develop understandings on the significance of culture for the society, connotation of personality in the corporate/professional world, learning attitude and self-motivation.
- CO 3. Develop the personality of the students for the agri professional world, self-assessment, learn rectification and self-improvement.
- CO 4. Develop the evaluative thinking on need of soft skills (self-motivation, learning attitude, positive attitude, aspiring thoughts) while improvising oneself. Analysing attitudes of rural societies, nature and structures of rural society and components of rural society.
- CO 5. Analyze the salient features of personality and learning development.
- CO 6. Evaluate the intelligence, motivation, various theories of motivation

Course content

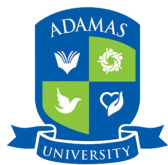
Unit 1. Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society.

Unit 2. Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development.

Unit 3. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

Suggested Readings:

- Mertens, M.D. (2014), Research and evaluation in education and psychology. Sage publication.
- Mazur, J.E. (2017) Learning and behaviour. Prentice Hall, New Delhi.
- Klausmier, H.J.. Educational psychology. Harper and Row, New York.
- Dubious, N.F.. Educational psychology and instructional decisions. Dorsey press



8. AGR13008: Fundamentals of Crop Physiology (L-T-P :2-0-1) Credit: 3(2-0-1)

- CO-1. Impart the knowledge of physiological phenomenon in plant cells, absorption of water, transpiration, diffusion, osmosis, imbibition, mineral nutrition of plants, plant growth and regulators, etc.
- CO-2. Develop the understanding of mechanisms of various metabolic processes in plants - Photosynthesis, respiration, TCA cycles, plant growth, nutrient absorption, etc.
- CO-3. Develop the skills in preparation of temporary slides for morphological studying plant cells, measurement of distribution of stomata, osmosis, plasmolysis, determination of rate of transpiration, root pressure, separation of photosynthetic pigments, estimation of relative water content, measurement of photosynthetic CO₂ assimilation, etc.
- CO-4. Develop an ability to identify C₃, C₄ and CAM plants, analyse the physical and chemical factors regulate plant growth, evaluate visual symptoms of nutrient deficiency in plants, etc.

Course content

Theory

Unit 1. Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology

Unit 2. Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; Photosynthesis: Light and Dark reactions, C₃, C₄ and CAM plants

Unit 3. Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism: Fatty acid synthesis and Breakdown

Unit 4. 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

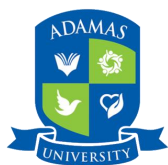
Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, Separation of photosynthetic pigments through paper chromatography, Rate of transpiration, photosynthesis, respiration, tissue test for mineral nutrients,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

Suggested Readings:

- Plant Physiology. Salisbulry. 2007. CBS. New Delhi
- Plant Growth Substances. CBS. Richard, N. Arteca. 2004. New Delhi.
- Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation Aswanipareek, S.K. Sopory, Hans BohnertGovindjee.
- Plant Physiology S N Pandey and B K Sinha, Vikas Publishers
- Plant Physiology. Zeiger. 2003. PANIMA. New Delhi
- Handbook of Crop Physiology, 2014 CRC Press by Mohammad Pessarakli

9. AGR11009: Comprehension and Communication Skills in English (L-T-P :2-0-1) Credit: 2(2-0-0)

- CO-1 The students acquire the significance of proficiency, both in spoken (oral) and written language.



CO-2 The student learn the ways to develop comprehension skills, improved vocabulary, significant use of grammar, acquired understanding on writing skills, corresponded with others and enhanced skills in spoken English. Acquaint the use of English knowledge as is to be used in the field of agriculture and its allied branches.

CO-3 Develop the understanding on the significance of communication and compared different types of communication with their use.

CO-4 Develop the skills in different categories of writing styles, their implications in various areas, formats to be followed under these styles of writing and their significance

Course content

Theory:

Unit 1. 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.

Unit 2. 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.

Unit 3. 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.

Unit 4. 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.

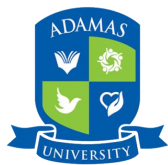
Suggested Readings:

1. Written and Spoken Communication in English, University Press (India) Pvt. Ltd.
2. Business Communication techniques and methods, by Om P. Juneja and Aarati Mujumdar, Orient BlackSwan Pvt. Ltd.
3. Strengthen your English, M. P. Bhaskaran, D. Horsburgh, Oxford University Press.
4. A Handbook of Standard English and Indian Usage-Vocabulary and Grammar, J. Sethi, Prentice Hall of India Pvt. Ltd.

10. BIT11003: Life Sciences (L-T-P: 1-0-1) Credit: 2(1-0-1)

CO- 1. To be acquainted with the basics terms describe life and its basic characteristics, taxonomy, evolution, etc.

CO-2 To develop an understanding of plant morphology, vital metabolisms of the cell, system of organizations, reproduction and seed germination, role of forest trees and animals in agriculture, etc.



CO- 3. To develop the ability in mounting tests of plant and creature cell/tissue microscopy, identification and classification of plants and creatures, categorization of inflorescence, blossom and natural products, etc.

CO- 4. Develop ability to differentiate characters of *Brassicaceae*, *Fabaceae*, *Poaceae* and other families of plants.

Course content

Theory

Unit 1. Introduction to the living world, diversity and characteristics of life, origin of life

Unit 2. Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division

Unit 3. 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, flowers and fruits. Cell, tissues & cell division. The internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - *Brassicaceae*, *Fabaceae* and *Poaceae*.

Suggested Readings:

- Biology: The Essentials 2017. by Mariëlle Hoefnagels McGraw-Hill Publishers
- Life: An Introduction to Biology by George Gaylord Simpson and William S. Beck, Longman Higher Education Publishers
- Biology: Life on Earth with Physiology by Audesirk/Audesirk/Byers, Pearson Publishers

11. Elementary Mathematics (L-T-P: 2-0-0) Credit: 2(2+0)

CO-1. Extend the concept of straight lines, circle, calculus, functions, differentiation, integration, area of circle, triangle and quadrilateral, etc.

CO- 2. To be familiar with the equations for straight lines, parallel lines, perpendicular lines, angles between two lines, points where two straight lines intersect, circles, triangles, quadrilaterals, and circles, as well as calculus calculations, functions, differentiation, integration, and other topics.

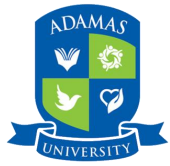
CO-3. To be able to test hypothetical values against mathematical equations involving straight lines, parallel lines, perpendicular lines, angle of bisectors, circles, calculus, functions, differentiation, integration, circle, triangle, and quadrilateral areas, among others.

CO-4. Develop ability to apply mathematical calculations in agriculture and allied sciences.

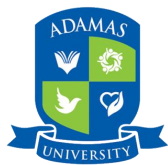
Course content

12. AGR13024 National Service Scheme (L-T-P: 0-0-2) Credit: 2(0+2)

CO-1. To understand the community in which they work and integrate themselves in relation to their community



- CO -2. To identify the needs and problems of the community and involve them in problem-solving besides developing among themselves a sense of social and civic responsibility
- CO 3. To utilise their knowledge in finding practical solutions to individual and community problems and to develop competence required for group-living and sharing of responsibilities
- CO 4. To gain skills in mobilising community participation acquire leadership qualities and democratic attitudes.



SEMESTER II

1. AGR 13010: Agriculture Microbiology (L-T-P: 2-0-1) Credit: 3(2+1)

CO1. Acquaint with basic terms of microorganisms, prokaryotic and eukaryotic microbes, microbial growth, pure culture, microbial association, soil fertility, symbiotic, associative and asymbiotic of microbes, bio-fertilizers, biopesticides, bio-degradation, etc.

CO 2. Develop the understanding of the role of microbes in soil fertility, crop production and human welfare.

CO. 3. Develop the skills in utilization of various methods, equipment, laboratory tools, glassware, etc. for isolation, identification, preservation, classification and utilization of useful microbes.

CO. 4. Develop the ability to differentiate useful, virulent and non-useful microbes.

Course content

Theory

Unit 1: Introduction. Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination, transformation, conjugation and transduction, plasmids, transposon.

Unit 2: Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles.

Unit 3: Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere.

Unit 4: Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste

Practical

Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and their preparations. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes. Methods of isolation and purification of microbial cultures. Isolation of Rhizobium from legume root nodule. Isolation of Azotobacter from soil. Isolation of Azospirillum from roots. Isolation of BGA. Staining and microscopic examination of microbes.

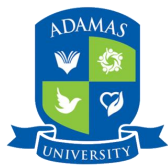
Suggested Readings:

Soil Microbiology - R.M. Aggarwal, 2013. Wisdom Press/Dominant Publishers and Distributers

Fundamental Agricultural Microbiology K R Aneja, New Age International Publishers

Biofertilizer Technology, Singh and Purohit, 2008. Agrobios

Agricultural Microbiology, Rangaswamy, G, PHI Publication



2. AGR13018: Soil and Water Conservation Engineering (L-T-P: 1-0-1) Credit: 2(1+1)

CO-1 Learn the soil and water conservation techniques and provide knowledge about soil erosion, their causes and agents.

CO-2 Develop the knowledge about water erosion, Gully classification, their control and soil loss measurement techniques.

CO-3 Develop the knowledge and understanding of the mechanical measure for controlling soil and water erosion.

CO-4 Develop the skills about water harvesting, their techniques, wind erosion and their control.

Course content

Theory

Unit 1: Introduction to Soil and Water Conservation, causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures.

Unit 2: Soil loss estimation by universal Loss Soil Equation. Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing.

Unit 3: Grassed water ways and their design. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

General status of soil conservation in India. Calculation of erosion index. Estimation of soil loss. Measurement of soil loss. Preparation of contour maps. Design of grassed water ways. Design of contour bunds. Design of graded bunds. Design of bench terracing system. Problem on wind erosion.

Suggested Readings:

Land and Water Management Engineering. 4th Edition, Murthy, V.V.N. 2002. Kalyani Publishers, New Delhi.

Manual of Soil and Water Conservation Practices. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

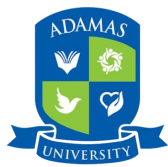
Soil and Water Conservation Engineering. Suresh, R. 2014. Standard Publisher Distributors, New Delhi.

Soil and Water Conservation Engineering. 4th Edition, Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert John Wiley and Sons Inc. New York.

Water Harvesting and Recycling: Indian Experiences. Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. CSWCR&TI, Dehradun, Allied Printers, Dehradun.

3. AGR11016: Fundamentals of Agricultural Economics (L-T-P: 2-0-0) Credit: 2(2+0)

CO-1. Understand the different concepts of Agricultural economics, nature of economics, human behaviour, goods and services, need, want, demand, etc.



- CO-2. Understand the law of demand, law of supply, elasticity of demand and supply, factor of production, barter system, consumer surplus etc.
- CO-3. Apply the different laws in agricultural market, market structure, agricultural taxation, etc.
- CO-4. Analyze the national income, concepts of national income accounting and approaches to measurement etc.
- CO-5. Evaluate the role of banking in rural credit etc.

Course content

Theory

Unit 1: 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.

Unit 2: 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, schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle.

Unit 3: 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: concepts, short run and long run cost curves. Supply: Stock v/s supply, law of 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.

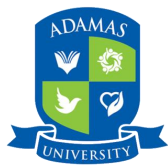
Unit 4: Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. National income: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socioeconomic 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, supply, general price index, inflation and deflation.

Unit 5: 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:

Fundamentals of Agricultural Economics 2016. A Marjeet Singh, A N Sadhu and J Singh, Himalya Publishing

House Fundamentals of Entrepreneurship. Nandan H. 2011. PHI Learning Pvt Ltd India.



Essentials of Management: An International Perspective, 2nd Ed. Harold Koontz & Heinz Weihrich. Tata Mc-Graw Hill Publishing Pvt Ltd.

The Agribusiness Book. Mukesh Pandey & Deepali Tewari. 2010. IBDC Publishers.

4. AGR13017: Fundamentals of Agricultural Extension Education (L-T-P: 2-0-1) Credit: 3(2+1)

CO-1 Acquaint the knowledge on concept, objectives, principles and philosophy of extension management.

CO-2 Develop an understanding on the process, steps, principles and monitoring and evaluation involved in agricultural extension programme development for transfer of technology.

CO-3 Develop the skills about genesis of agricultural extension, extension efforts in pre- and post-independence era along with specific agricultural programmes.

CO-4 Apply new trends in agricultural extension like private extension, market led extension, expert systems, farmer led extension and cyber extension.

CO-5 Evaluate different facets of rural development programmes, community development programmes, rural leadership for capacity development of extension clientele.

CO-6 Apply communication strategies using agricultural journalism for innovation, diffusion and adoption of agricultural technology.

Course content

Theory

Unit 1: 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.).

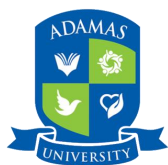
Unit 2: New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc. Rural Development: concept, meaning, definition; various rural development programmes launched by Govt. of India.

Unit 3: Community Development-meaning, definition, concept & principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions.

Unit 4: 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, ICT Applications in TOT (New and Social Media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; handling and use of audio visual equipments and 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; A visit to 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; 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:

Agricultural Extension 2015. Sagar Mondal, Kalyani Publishers

Extension Education, Adivi Reddy, A., 2001, Sree Lakshmi press, Bapatla.

Fundamentals of Extension Education and Management in Extension, Concept Jalihal, K. A. and Veerabhadraiah, V., 2016, publishing company, New Delhi.

Ray, G. L., 1991 (1st Edition), Extension Communication and Management, Kalyani Publishers, Ludhiana {7th revised edition, 2016}.

5. AGR13011: Crop Production Technology – I (Kharif Crops) (L-T-P: 1-0-1) Credit: 2(1+1)

CO-1 Acquaint the knowledge on kharif crops, its classification (cereal crops, oilseed crops, pulse crops, sugar crops, fodder crops) and its importance in agriculture and national economy

CO-2 Discuss the production techniques of kharif crops and their origin, economic importance, geographical distribution and botanical description.

CO-3 Implement the cultivation methods of kharif crops in the field and their management.

CO-4 Crop protection methods of all kharif crops (rice, millet, soybean, moong , etc.) with their cultivation practices.

Course content

Theory

Unit 1: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of crops Cereals- rice, maize, sorghum, pearl millet and finger millet;

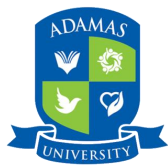
Unit 2: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of crops pulses-pigeonpea, mungbean and urdbean; oilseeds-groundnut, and soybean;

Unit 3: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of crops fibre crops- cotton & jute;

Unit 4: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of crops 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:

Reddy SR. Principles of Agronomy. Kalyani Publishers.

Balasubrananiyan P & Palaniappan SP. 2015. Principles and Practices of Agronomy. Agrobios

Reddy Yellamanda T and Shankar Reddy G H. New Edn. Principles of Agronomy. Kalyani Publishers Ludhiana.

Gupta O P. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.

Yawalkar K S and Agarwal J P. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.

6. AGR13012: Fundamentals of Entomology (Insect Morphology and Taxonomy) (L-T-P: 2-0-1) Credit: 3(2+1)

CO-1 Educate the basic concept of entomology, insect collection and preservation, dissection, and morphology of insects.

CO-2 Develop the understanding of anatomy, physiology, the taxonomy of different classes of insects, and the effect of biotic and abiotic factors on insects.

Course content

Theory

Unit 1: History of Entomology in India. 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.

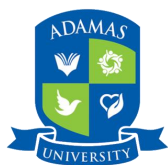
Unit 2: Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ.

Unit 3: 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.

Unit 4: Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

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)



Suggested Readings:

Handbook of Entomology by T V Prasad 2016. Kindle Edition.

Introduction to General and Applied Entomology. Awasthi, V.B. Scientific Publishers, Jodhpur, 379 p.

The Insects: Structure and Function. Chapman, R.F. 1981. Edward Arnold (Publishers) Ltd, London
General Entomology. Mani, M.S. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi

Biology of Insects. Saxena, S.C. 1992. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

An introduction to Entomology, Srivastava, P.D. and R.P. Singh. 1997. Concept Publishing Company, New Delhi, 269p

The Science of Entomology, Romoser, W.S. McMillan, New York, 449p.

Entomology and pest management. III Edition. Pedigo, L.P. 1999. Prentice Hall, New Jersey, USA

7. AGR13014: Fundamentals of Plant Pathology (Mycology) (L-T-P: 2-0-1) Credit: 3(2+1)

CO 1. Imparting concepts, nomenclature, classification and characters of fungi.

CO 2. Understanding of disease identification, nature of pathogens and different strategies for management of plant diseases.

CO 3. Able to distinguish the fungicides and antibiotics (mode of action and formulations) on the basis of Nature of pathogen.

Course content

Theory

Unit 1: 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. Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases.

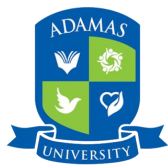
Unit 2: Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes.

Unit 3: Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual).

Unit 4: Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes.

Unit 5: Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants.

Unit 6: Epidemiology: Factors affecting disease development. 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. Collection and preservation of disease specimen. 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.

Suggested Readings:

N.G. Ravichandra, 2013. Fundamentals of Plant Pathology. PHI Hall of India, New Delhi

Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.

Mandahar, C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi

8. Fundamentals of Genetics & Molecular Biology (L-T-P: 2-0-1) Credit: 3(2+1)

CO 1: Acquaint with concepts, scope, and importance of genetics in the field of agriculture

CO-2: Develop the understanding of Mendelian principles and their significance in heredity and inheritance of Qualitative & Quantitative traits

CO-3: To interpret the process and purpose of cell division, linkage, crossing over, gene interaction, sex determination, and blood group genetics, mutation and its effects

CO-4: To understand the process of DNA replication, transcription and translation process.

Course content

Theory

Unit 1: Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; special types of chromosomes. Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example.

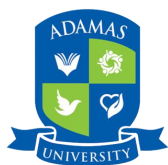
Unit 2: Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications.

Unit 3: Use of haploids, dihaploids and doubled haploids in Genetics. Mutation, classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance. Genetic disorders.

Unit 4: 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. Mitosis and Meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and 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 structures.

Suggested Readings:

Fundamentals of Genetics Singh B D. Kalyani Publishers, New Delhi

Understanding Genetics (I Ed.) Norman, V. Rothwell. Oxford University Press, Oxford

Principles of Genetics (II Ed). Gardner E J, Simmons M J & Snustard D P. John Wiley & Sons, New York.

9. AGR13013: Agro-meteorology and Climate Change (L-T-P: 2-0-1) Credit: 3(2+1)

CO-1: To understand roles of agrometeorology in agriculture and its relation to crop production and to acquaint with recent developments in agrometeorology with historical development of climate change.

CO-2: Agrometeorology with relation to meteorological and hydrological factors in relation to agriculture.

CO-3: Agrometeorology studies the behaviour of the weather elements that have direct relevance to agriculture and their effect on crop production.

CO-4: Weather and climate are the factors determining the success or failure of agriculture.

CO-5: To develop weather based agro advisories to sustain crop production.

Course content

Theory

Unit 1: Meaning and scope of agricultural meteorology; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze;

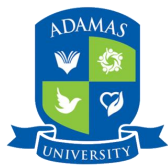
Unit 2: Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapour pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking

Unit 3: Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production.

Unit 4: Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation



using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

Suggested Readings:

Introduction to Agrometeorology and Climate Change. Alok Kumar Patra. 2022. New India publishing agency

10. AGR13019: Livestock and Poultry Production (L-T-P: 2-0-1) Credit: 3(2+1)

- CO-1 Give knowledge of indigenous and exotic breeds of cattle, buffalo, sheep, goat and poultry birds (poultry, duck, fowl).
- CO-2 Develop the understanding of principles, planning, and technical approach for reproduction management in different farm animals. And introduce the diseases of livestock and poultry and its prevention (including vaccination schedule) and control of important diseases of livestock and poultry.
- CO-3 Develop ability to select types of houses suited in specific climatic conditions for best management of calves, growing heifers and milch animals.
- CO-4 Develop the understanding digestion system of livestock and poultry, classification of feedstuffs, nutrients and their functions, feed supplements, feed additives, and feeding of livestock and poultry and develop ability to calculate daily ration of cattle.
- CO-5 Visit of the dairy and poultry farms to study breeds of livestock and poultry and daily routine farm operations and farm records

Course content

Theory

Unit 1: Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers

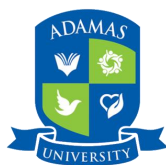
Unit 2: Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry

Unit 3: Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry.

Unit 4: Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle,



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

Suggested Readings:

Banerjee GC. 1989. Text Book of Animal Husbandry. Oxford and IBH.

ICAR. 1962. Handbook of Animal Husbandry. ICAR Publication.

Parsad Jagdish. 2001. Poultry Production and Management. Kalyani Publishers.

Sastry NSR & Thomas CK. 1991. Dairy Bovine Production. Kalyani Publishers.

Singh RA. 1990. Poultry Production. Kalyani Publishers.

11. MTH1534 Fundamentals of Biostatistics (L-T-P: 2-0-0) Credit: 2(2+0)

CO 1: Educate basics terms used in statistics and biostatistics.

CO 2: Develop the understanding of use of various formulas, principles and methods of statistical calculations used in agriculture.

CO 3: Develop the skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.

CO 4: Develop ability to analyse results of statistical calculations and their validation.

CO 5: Develop ability to make statistical hypothesis and design experiment in agriculture

Course content

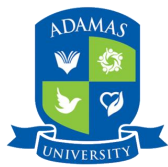
Theory

Unit 1: Definition of statistics, its use and limitations; Frequency distribution and frequency curve and cumulative frequency curve; Measures of central tendency; Measures of dispersion; Probability: Definition, additive and multiplicative law for two events; Normal distribution and its properties; Introduction to sampling; Sampling techniques

Unit 2: Tests of significance: Null hypothesis, alternate hypothesis, Type I & II Error, one and two tail tests, level of significance and confidence interval; SND test for means: Single sample and two samples Z-test; Student's t-test for means, single sample, two samples and paired t-test; F-test

Unit 3: Chi-square test in 2x2 contingency table; Yate's correction for continuity; Correlation: Scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing; Linear regression and its properties; Analysis of variance and its assumptions, Analysis of CRD and RBD; Analysis of Latin Square Design. Analysis of variance and covariance; Incomplete block designs; Estimation and significance of genotypic and phenotypic variation; detection of linkage, linkage ratios and its estimation;

Unit 4: Baye's theorem and its applications; Introduction to Uniform, Binomial, Poisson, Normal, Exponential and Gamma probability distributions. Random mating populations, Hardy-Weinberg Law; Introduction to Poisson process and Markov chains: Transition probability matrix, n-step



transition probabilities, steady state. Random walk models; Sensitivity and specificity. Incomplete block designs; Testing of heritability

Practical

Construction of frequency distribution tables and frequency curves; Computation of Arithmetic: Mean, median, mode; Standard deviation; Variance and coefficient of variation for ungrouped and grouped data; SND test for means; Student's t-test; F-test and Chi-square test; Correlation coefficient 'r' and its testing; Fitting of regression equations; Analysis of CRD, RBD and LSD.

Suggested Readings:

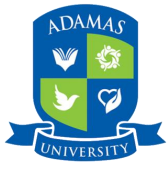
Chandel SRS. A Hand book of Agricultural Statistics. Achal Praskasam Masndir, Kanpur.

Agrawal B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.

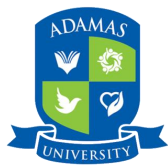
Nageswara Rao G. Statistics for Agricultural Sciences. BS Publications.

Rangaswamy R. A Text Book of Agricultural Statistics. New Age Int. publications Ltd.

Gupta S.C. Fundamental Applied Statistics.



SEMESTER III



1. AGR13020: Crop Production Technology II (Rabi Crops) (L-T-P: 2-0-1) Credit: 3(2+1)

CO.1. To know the Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of rabi crops

CO.2. Identify weeds in rabi season crops, Pulses-chickpea, lentil, peas; oilseeds-rapeseed, mustard and sunflower; sugar crops-sugarcane, Medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops-berseem, lucerne and oat

CO.3. Thorough proper knowledge of irrigation scheduling in rabi crops, additional area can be increased of low water requiring crops

CO.4. Students will be able to know about the economic importance of medicinal and Aromatic crops in present sphere.

CO.5. It will be helpful to know about basic morphological characteristics of rabi crops

Course content

Theory

Unit 1: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of Rabi crops- cereals –wheat and barley.

Unit 2: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of Rabi crops- pulses-chickpea, lentil, peas, oilseeds-rapeseed, mustard and sunflower.

Unit 3: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of Rabi crops- sugar crops-sugarcane; medicinal and aromatic crops-mentha, lemon grass and citronella,

Unit 4: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of Rabi crops- Forage crops-berseem, lucerne and oat

Practical

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

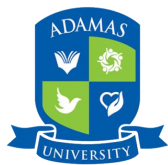
Suggested Readings:

Reddy SR. Principles of Agronomy. Kalyani Publishers.

Balasubrananiyan P & Palaniappan SP. 2015. Principles and Practices of Agronomy. Agrobios

Reddy Yellamanda T and Shankar Reddy G H. New Edn. Principles of Agronomy. Kalyani Publishers Ludhiana.

Gupta O P. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.



Yawalkar K S and Agarwal J P. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur

2. AGR13021: Fundamentals of Plant Breeding (L-T-P: 2-0-2) Credit: 3(2+1)

CO 1. List out various contribution, the significance of plant breeding and its milestone in the field of agriculture

CO 2. Develop the understanding about modes of selection, the evolution of crops, conservation of genetic resources, population genetics and significance of IPR in crop improvement

CO 3. Sketch the breeding objectives and implementation of different selection methods and hybridization techniques for various field crop

CO 4. Distinguish the breeding method for self, cross and asexually propagated crops.

Course content

Theory

Unit 1: 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 and Introduction; Centres of origin/ diversity

Unit 2: Components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept. Concepts of population genetics and Hardy-Weinberg Law.

Unit 3: Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement Schemes-Ear to row method, Modified Ear to Row, recurrent selection schemes; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Maintenance of breeding records and data collection

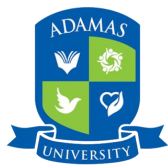
Unit 4: Wide hybridization and prebreeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, 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 experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

Suggested Readings:

Singh, B.D., 1997. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi. P. 702.



Kundan Singh, Essentials of plant breeding

Phundan Singh, 1992. Genetic. Kalyani Publishers, New Delhi, P. 509.

Trivedi PC. 2000. Plant Biotechnology: Recent Advances. Panima Publishers

Chahal GS & Gosal SS. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa Publishers

3. AGR13022: Fundamentals of Entomology II (Insect Ecology and their management (L-T-P: 2-0-1) Credit: 3(2+1))

- CO 1. Educate the basic concept of entomology, insect collection and preservation, dissection, and morphology of insects
- CO 2. Develop the understanding of anatomy, physiology, the taxonomy of insects, and the effect of biotic and abiotic factors on insects
- CO 3. Demonstrate the principles of Pest surveillance, Pest forecasting, recent and traditional methods of pest management including IPM
- CO 4. Evaluate the economic importance of insects and eco-friendly control measures for pest management to sustainable agriculture
- CO 5. Formulate the application of Insecticides and mass production techniques of Bio-control agents.

Course content

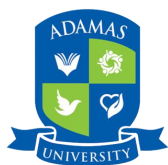
Theory

Unit 1: 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.

Unit 2: 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.

Unit 3: 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, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae. Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical



Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

Suggested Readings:

Handbook of Entomology by T V Prasad 2016. Kindle Edition.

Introduction to General and Applied Entomology. Awasthi, V.B. Scientific Publishers, Jodhpur, 379 p.

The Insects: Structure and Function. Chapman, R.F. 1981. Edward Arnold (Publishers) Ltd, London

General Entomology. Mani, M.S. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi

Biology of Insects. Saxena, S.C. 1992. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

An introduction to Entomology, Srivastava, P.D. and R.P.Singh. 1997. Concept Publishing Company, New Delhi, 269p

The Science of Entomology, Romoser, W.S. McMillan, New York, 449p

4. AGR13023: Principles of Plant Pathology (L-T-P: 2-0-1) Credit: 3(2+1)

CO 1. Imparting concepts, nomenclature, classification and characters of pathogens.

CO 2. Understanding of disease identification, nature of pathogens and different strategies for management of plant diseases

CO 3. Applying different principles and methods for plant disease management

CO 4. Able to distinguish the fungicides and antibiotics (mode of action and formulations) on the basis of Nature of pathogen

CO 5. Develop the skills of crops diseases identification and marketing of relevant pesticides.

Course content

Theory

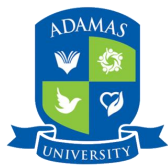
Unit 1: Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases

Unit 2: Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction. Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites.

Unit 3: Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, Anguina, Radopholus etc.)

Practical

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. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

Suggested Readings:

N.G. Ravichandra, 2013. Fundamentals of Plant Pathology. PHI Hall of India, New Delhi

Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.

Mandahar, C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi

5. AGR13024: Diseases of Field and Horticultural Crops and their Management I (Field Crops) (L-T-P: 2-0-1) Credit: 3(2+1)

CO 1. Student will know the common pathogens of different diseases of field crops

CO 2. Student acquire the knowledge about etiology, and symptoms of these diseases which helps in diagnosis of the diseases of field crops

CO 3. By knowing means of dispersal of these diseases suitable management methods can be applied.

CO 4. Eco-friendly and economically suitable management practices may be adopted

Course content

Theory

Unit 1: Symptoms, etiology, disease cycle and management of major diseases of Field Crops: Rice: blast, brown spot, bacterial blight, sheath blight, false smut, khaira and tungro; Maize: stalk rots, downy mildew, leaf spots

Unit 2: Symptoms, etiology, disease cycle and management of major diseases of Sorghum: smuts, grain mold and anthracnose, Bajra :downy mildew and ergot; Groundnut: early and late leaf spots, wilt Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Finger millet: Blast and leaf spot; black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic

Unit 3: Castor: Phytophthora blight; Tobacco: black shank, black root rot and mosaic.

Practical

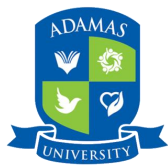
Identification and histopathological studies of selected diseases of field crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Note: Students should submit 50 pressed and well mounted specimens

Suggested Readings:

Fundamentals of Plant Pathology by RS Mehrotra and Ashok Aggarwal, McGraw Hill Education (India) Private Limited, New Delhi

Agrios, GN. 2010. Plant Pathology. Acad. Press.

Singh RS. 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co.



6. AGR13025: Agricultural Finance and Co-operation (L-T-P: 2-0-2) Credit: 3(2+1)

CO 1. Develop the ability to remember the rural credit structure and its salient features.

CO 2. Develop the ability to understand the terminology and facts about agriculture Finance and Cooperation

CO 3. Develop the ability to apply for loan as now they are aware about lending procedure of credit institutions

CO 4. Develop the ability to analyze the financial statements i.e., balance sheet and income statement and use it to know the performance of an institution

CO 5. Develop the ability to evaluate the credit structure of different credit institutions.

CO 6. Develop the ability to create a project report of a new agri- project

Course content

Theory

Unit 1: 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.

Unit 2: 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.

Unit 3: Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture.

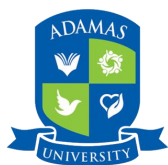
Unit 4: Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

Practical

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

Suggested Readings:

Benjamin MC Donald P. 1985, Investment Projects in Agriculture- Principles and Case studies. Longman Group Limited. Essex. UK.



Pandey U. K., An Introduction to Agricultural Finance.

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

7. Communication Skills and Personality Development (L-T-P: 1-0-2) Credit: 1-0-2

CO 1. Acquaint the knowledge on Listening, Speaking, Reading and Writing Skills along with classification; General & Technical Article and writing principles of these articles; comparison between Individual & Group presentation; organization of seminars & conferences and formats of Public Speaking

CO 2. Develop the understanding on usage of different classified skills according to situations, reading and writing of general & technical articles and the preparation and planning before organizing seminars and conferences

CO 3. Develop the skill of students towards general & technical writing, principles of reading and writing of general & technical articles and implication

CO 4. Develop evaluative thinking on variations between General & Technical Articles with the way of writing, how to prepare for public speaking and the principles to be followed and significance of Field Diary & Lab Record for an agriculture student.

Course content

Theory

Unit 1: Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication

Unit 2: Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures

Unit 3: Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking

Unit 4: Group discussion. Organizing seminars and conferences. Voice modulation basics and their usage for meaningful impact on people; Attributes of an effective leader; Stress and conflict management; Time management: Personal organization, prioritizing and balancing; Cosmopolitan culture; Impact of non-verbal communication; Science of body language; Role of team work

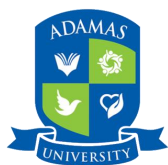
Practical

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.

Suggested Readings:

Human Communication: Motivation, Knowledge & Skills. Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. Wadsworth.

The Art of Communication. Verma, KC. 2013. Kalpaz



8. AGR13026: Ecophysiology (L-T-P: 1-0-2) Credit: 2(1+1)

CO-1. Study about the different stresses (biotic and abiotic) a plant on field goes through

CO-2. Study about the losses being occurring due to effect of stress

CO-3. Study about the importance of improvement in crops for tackling different kinds of stress

CO-4. Study about the resistance mechanisms developed in plants for tackling different kinds of stress

Course content

Theory

Unit 1. Ecophysiology - Introduction – Definition – Importance in Agriculture and Horticulture – Ecosystem- definition of ecosystem, ecotypes & ecads – Biosphere and Ecosystem: subdivisions of biosphere – pathways of energy in the biosphere – concept of ecosystem – components of ecosystem- Basic structure of ecosystem.

Unit 2. Different types of ecosystems – freshwater – marine – forest and crop ecosystem – Energy in Ecosystem – productivity – primary production –secondary production – types of food chains.

Unit 3. Global climate and crop distribution– Influence of climate on crop distribution (Rice, Wheat, Maize, Sorghum and Sugar cane)- Important climatic regions of the world- Agro-climatic zones of India -crop distribution in India

Unit 4. Environment – Definition – components - Biotic and Abiotic environments Biotic environment: Biotic factors and Anthropogenic factors, Abiotic environment: Climatic, edaphic. Physiographic and pyric factors- Climatic factors –Radiation – effect of radiation on plant functions - Classification of ultraviolet radiation- effects of UV-B radiation.

Unit 5. Abiotic environment- Climatic factors- precipitation – forms of precipitation Effect of water deficit and water logging on plant processes– temperature Cardinal temperature- effects of temperature on plant processes – temperature injuries – high temperature and low temperature stress classification of plants based on heat resistance and cold resistance – heat units.

Unit 6. Abiotic environment- Edaphic factors – Classification of plants based on adaptation to different soil types – halophytes and salt stress tolerance mechanisms.

Unit 7. Abiotic environment – physiographic factors, Altitude of the place –steepness of the slope, direction of mountain chain and exposure of the slope to light and wind- -effects of topographic factors on vegetation – wind effect on physiological processes.

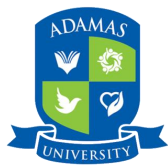
Unit 8. Biotic factors –herbivores (grazing effect), symbiosis (Mycorrhiza and Rhizobium associations), insectivorous plants, epiphytism and parasites Anthropogenic factors – industrialization- shifting cultivation –crop improvement.

Unit 9. Competition- Ecological Succession - dominance and subordination-types of competition- inter specific – intra specific and intra plant competition –Monoculture and Polyculture- Multi-storeyed cropping system – mutual shading.

Unit 10. Allelopathy – Definition- concept – sources of allelopathic chemicals in crop and weed species –natural products identified as allelopathic chemicals–mode of action – scope for allelopathy.

Unit 11. Phyto-remediation-Definition – concept – Applications in Agriculture and Industry.

Unit 12. Pollution - Air pollution – Sources – Physiological effects on plants and its management. Water pollution – sources- physiological effects on plants and its management, soil pollution- sources- physiological effects on plants and its management.



Unit 13. Global warming – Green house effect – causes of global warming- methane, Co₂, Chloro Fluoro Carbon's (CFC) and nitrous oxide (NO) gas, ozone –Impact of Global warming on climate and agricultural productivity – measures to reduce build up of Green House Gases.

Unit 14. Controlled environment – Purposes – types – designs of structures commercial applications.

Unit 15. Carbon dioxide fertilization –definition-concept-importance- Sources –Methods of CO₂ fertilization – effects on crop yields and limitations; Ecophysiological Models – concept – models for different environmental management

Practical: Understand the response of plants in relation to various environmental factors affecting plant growth and development

Suggested Readings:

Fabio Da Matta.2010. Ecophysiology of tropical tree crops. Nova Science Publisher

Narendra Tuteja and Sarvajeet S. Gill.2016. Abiotic Stress Response in Plants. Wiley-VCH

Adela M. Sánchez-Moreiras and Manuel J. Reigosa.2018. Advances in Plant Ecophysiology Techniques. Springer

9. AGR13027: Production Technology for Vegetables and Spices (L-T-P: 1-0-2) Credit: 2(1+1)

CO-1. Students will understand practical knowledge on specialized production techniques of vegetables and spices

CO-2. Students understand will Importance of vegetables & spices in human nutrition improved and national economy

CO-3. Students will knowledge about quality requirement and production and techniques

CO-4. Managing skill for solving field problems

Course content

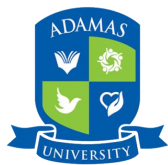
Theory

Unit 1: Importance of vegetables & spices in human nutrition and national economy, kitchen gardening

Unit 2: Brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Tomato, Brinjal, Chilli, Capsicum)

Unit 3: Brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Cucumber, Melons, Gourds, Pumpkin, French bean, Peas. Cole crops such as Cabbage, Cauliflower, Knol-khol)

Unit 4: Brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Bulb



crops such as Onion, Garlic; Root crops such as Carrot, Raddish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables)

Practical

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

Suggested Readings:

S. Thamburaj, 2014. Text book of vegetable, tuber crops and Spices. ICAR, New Delhi

B.R.Choudhary, 2009. A Text book on production technology of vegetables. Kalyani Publishers. Ludhiana.

T.K.Bose, 2002. Vegetable Crops. Nayaprakash. Kolkata

P.Hazra, 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi

10. AGR13028: Agriculture Engineering I (Farm Machinery and Power) (L-T-P: 1-0-2) Credit: 2(1+1)

CO- 1. Know about the various sources of farm power and their uses

CO-2. Know about working of IC Engines and their uses in modern equipment's

CO- 3. Know about various parts of tractors and their mechanism

CO- 4. Know about the financial aspects of using farm power

CO-5. Know about the various implements used in agriculture farm for various purposes

Course content

Theory

Unit 1: 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

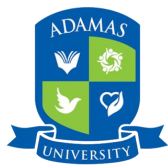
Unit 2: Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor,

Unit 3: 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

Unit 4: Implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization



with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow. Familiarization with seed cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter Familiarization with different types of sprayers and dusters Familiarization with different intercultivation equipment, Familiarization with harvesting and threshing machinery.

Suggested Readings:

T. P. Ojha and A.M. Michael. 2005. Principles of Agricultural Engineering (Volume - 1), Jain Brothers

Manoj Kumar Ghoshal and Dharendra Kumar Das. 2008. Farm Power, Kalyani publishers.

Surendra Singh. 2007. Farm Machinery Principles and Applications. ICAR Publications

M.M. Pandey & Others. 2012. Handbook of Agricultural Engineering. ICAR publication

11. SOC14100: Community Service (L-T-P: 0-0-0) Credit: 1(0+1)

CO-1. To familiarise the students on the concept 'giving back to the society'

CO- 2. To familiarize the students on the issues faced by marginalized communities

CO-3. Utilize the concept of social responsibility through an internship

Practical: To carryout social services within the communities viz. old age homes, orphanages, asylums, panchayat and also with the society in general and develop a empathy with the disadvantaged members of the society. It also includes dissemination social information to the community and also develop an understanding of the disadvantaged members of the society.

Suggested Readings:

12. EIC11001: Venture Ideation (L-T-P: 2-0-0) Credit: 2(2+0)

CO-1. Assess personal capacity in the context of the entrepreneurial process

CO -2. Assess characteristics of successful entrepreneurs and entrepreneurial forms and processes

CO 3. Apply resources, research and tools for entrepreneurial ventures

CO 4. Analyse and apply opportunity identification techniques, feasibility terminology, processes and models

CO 5. Develop Ideation and planning documents for entrepreneurial venture



SEMESTER IV



1 AGR13029 Agricultural Chemistry & Toxicology (L-T-P: 1-0-1) Credit: 2(1+1)

CO 1 To access the different aspects of soil chemistry and its relationship with plant growth

CO2: To understand the methods to improve crop productivity under problem soil conditions

CO3: To understand the effect of agro chemicals on harmful and beneficial living organisms

CO4: To access the effects of different agro chemicals on the environment

Course content

Unit 1: Concept and importance of soil solution; chemistry of soil water; dynamic nature of soil; soil and plant nutrition. Thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

Unit 2: Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids

Unit 3 : soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions. Ion exchange processes in soil; cation exchange- theories based on law of mass action (KerrVanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms,

Unit 4 :Anion and ligand exchange – innersphere and outersphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; ion exchange phenomena and implications in plant nutrition.

Unit 5: Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity, soil acidity reclamation. Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils

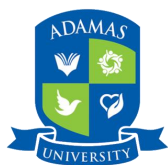
UNIT 6 Definition and scope of insecticide toxicology; Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrazoles, new promising compounds, etc.

Unit 7 Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides-synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

Unit 8 Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Practical

Determination of pH of water of pH meter/conductivity meter. Determination of nitrate from water. Analysis of lime content of soil. Colorimetric estimation of Fe, Zn, Mn, B, Cu, Mb from soil Photometric determination of K⁺, Na⁺, Ca⁺⁺, Mg⁺⁺, in soil. estimation of sulphate and phosphate. Determination of Organic carbon Conductometric analysis of salinity of soil Colorimetric analysis of phosphorous from soil Flame Photometric Estimation of potassium from soil. Estimate of



nitrogen by Kjeldahl's method. Laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices

Suggested Reading

Bailey, Steven, Collier, Rosemary, Harrison, R. M., Hester, R. E., Jones, Huw D., Lampkin, Nicolas, McConnell, Laura, McDowell, Richard, Moffat, Colin.2016. Agricultural Chemicals and the Environment: Issues and Potential Solutions. Royal Society of Chemistry.
N T Faithfull.2002. Methods in agricultural chemical analysis: a practical handbook.CAB Publishers
Stenersen, J.2004.Chemical Pesticides - Mode of Action and Toxicology. CRC Press
Richard P Pohanish.2015. Sittig's handbook of pesticides and agricultural chemicals. Elsevier Inc

2. AGR13030 Weed Management (L-T-P: 1-0-2) Credit: 2(1+1)

CO.1: Students will be acquainted about why to undertake environmental weed control.
CO.2: Students will be acquainted about different approaches of weed management.
CO.3: Students will be acquainted about harmful and beneficial effects of weeds in Agriculture.
CO.4: Students will be acquainted planning for weed management and weed management processes

Course content

Unit 1: Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds.

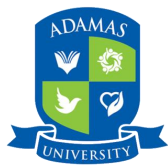
Unit 2: Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicides and selectivity.

Unit 3: Allelopathy and its application for weed management Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture

Unit 4: Herbicide compatibility with agro-chemicals and their application. Integration of herbicides with non-chemical methods of weed management. Herbicide Resistance and its management

Practical: Techniques of weed preservation. Weed identification and their losses study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and agrochemicals study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipment's. Calculations of herbicide doses and weed control efficiency and weed index.

Suggested Reading:



Thomas J. Monaco, Steve C. Weller, Floyd M. Ashton.2002. Weed Science: Principles and Practices, 4th edition. Wiley-Blackwell
V S Rao.2000. Principles of Weed Science. CRC Press
Robert L. Zimdahl.2007. Fundamentals of Weed Science, Third Edition. Academic Press
Harinder P. Singh Daizy Rani Batish , Ravinder Kumar Kohli .2006. Handbook of Sustainable Weed Management. CRC Press
Kassio Ferreira Mendes, Antonio Alberto da Silva.2022. Applied Weed and Herbicide Science. Springer
Per Kudsk.2022. Advances in integrated weed management. Burleigh Dodds Science Publishing

3. AGR13031 Principles of Seed Processing Technology (L-T-P: 2-0-2) Credit: 3(2+1)

- CO-1: Start a seed production program for fill full the requirement of quality seed in market and increase the income.
CO-2: Storage the pure variety seed to avoid the availability crises of pure variety seed due to adverse environmental conditions.
CO-3: To supply the disease free seed in the market to get the environment friendly cultivation of crops.
CO-4: To increase the farm income by producing high yielding disease free quality seed and decrease the cost of cultivation also.
CO-5: Production of hybrid seed of different crops to increase the farm income

Course content

Unit 1: Seed and seed technology: introduction, definition and importance. Deterioration causes of crop varieties and their control.

Unit 2: Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed. Foundation and certified seed production of important cereals, pulses, oilseeds, fodder and vegetables.

Unit 3: 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,

Unit 4: 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.

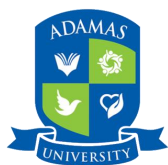
Unit 5: Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing. Seed storage; general principles, stages and factors affecting seed longevity during storage.

Unit 6: Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional media

Unit 7: Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies.

Practical

Seed production in major cereals: Wheat, Rice, Maize, Sorghum, Bajra and Ragi. Seed production in major pulses: Urd, Mung, Pigeonpea, Lentil, Gram, Field bean, pea. Seed production



in major oilseeds: Soybean, Sunflower, Rapeseed, Groundnut and Mustard. Seed production in important vegetable crops. Seed sampling and testing: Physical purity, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: Grow out test and electrophoresis. Seed certification: Procedure, Field inspection, Preparation of field inspection report. Visit to seed production farms, seed testing laboratories and seed processing plant.

Suggested Reading

Lawrence O. Copeland, Miller B. McDonald.2001. Principles of Seed Science and Technology. Springer

J. Derek Bewley, Kent J. Bradford, Henk W.M. Hilhorst, Hiro Nonogaki.2013. Seeds: Physiology of Development, Germination and Dormancy, 3rd Edition. Springer

Larry O. Copeland, Miller B. McDonald.1999. Principles of Seed Science and Technology. Springer

4. AGR13032 Crop Improvement I(*Cereals, Millets, Pulses and Oilseeds*) (L-T-P: 1-0-2) Credit: 2(1+1)

CO-1: In this course Students learn importance of wild relative to produce new varieties of kharif crop.

CO-2: To access the importance and methods of conservation method for further use to improve kharif crops.

CO-3: Learner learns to apply breeding method to improve kharif crops.

CO-4: Learner learns identification of tolerance gene relate to kharif crop with high yield potential against Pest and pathogen and utilization genes.

CO-5: Assessment of new genetic approaches to achieve a definite ideotype of kharif crop

Course content

Unit 1: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops.

Unit 2: 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.

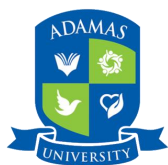
Practical

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

Suggested Reading

Chidida Singh, Prem Singh, Rajbir Singh.2021. Modern Techniques of Raising Field Crops, 3rd. CBS Pub.

Mirza Hasanuzzaman.2019. Agronomic Crops: Volume 1: Production Technologies. Springer



Mirza Hasanuzzaman.2019. Agronomic Crops: Volume 2: Production Technologies. Springer

5. AGR13033 Manures, Fertilizers and Soil Fertility Management (L-T-P: 1-0-2) Credit: 2(1+1)

CO1: Knowledge of different manure and fertilizers used in different crops according to soil condition

CO2: To understand essentiality of plant nutrients and mechanism of nutrient transport to plant and factor affecting nutrient availability.

CO3: To be able about procedure of soil testing and establish soil testing laboratory in future as a entrepreneur.

Course content

Unit 1: Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management.

Unit 2: Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order.

Unit 3: History of soil fertility and plant nutrition. criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants.

Unit 4: Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests.

Unit 5: Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions.

Practical

Introduction of analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of soil organic carbon, Estimation of alkaline hydrolysable 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 Reading

Kyoung S. Ro, Ariel A. Szogi, Gilbert C. Sigua.2019. Innovative Animal Manure Management for Environmental Protection, Improved Soil Fertility and Crop Production.MDPI

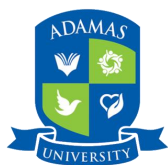
Langdon R. Elsworth, Walter O. Paley.2008. Fertilizers: Properties Applications and Effects. Nova Science Publishers

Zhongqui He.2011. Environmental Chemistry of Animal Manure. Nova Science Pub Inc

Sven G. Sommer, Morten L. Christensen, Thomas Schmidt, Lars S. Jensen.2013. Animal Manure Recycling: Treatment and Management. Wiley

John L. Havlin.2016. Soil Fertility and Fertilizers. Pearson India

Deepak G. Panpatte, Yogeshvari K. Jhala.2019. Soil Fertility Management for Sustainable Development. Springer



6. AGR13034 Diseases of Field and Horticultural Crops and their Management II (Horticultural Crops) (L-T-P: 1-0-2) Credit: 2(1+1)

CO-1. Student will know the common pathogens of different diseases.

CO-2. Student acquire the knowledge about etiology, and symptoms of these diseases which helps in diagnosis of the diseases of field and horticultural crops

CO-3. By knowing means of dispersal of these diseases suitable management methods can be applied.

CO-4. Eco-friendly and economically suitable management practices may be adopted.

Course content

Unit 1: Horticultural Crops: Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis; Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl.

Unit 2: Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic; Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch, and Stemphylium blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leaf spot.

Practical

Identification and histopathological studies of selected diseases of horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium. Students should submit 50 pressed and well-mounted specimens.

Suggested Readings:

J N Srivastava, A K Singh.2021. Diseases of Horticultural Crops: Diagnosis and Management: Volume 1: Fruit Crops. Apple Academic Press

Gireesh Chand , Md. Nadeem Akhtar , Santosh Kumar .2020. Diseases of Fruits and Vegetable Crops-Recent Management Approaches. Apple Academic Press

R. Kenneth Horst.2013. Field Manual of Diseases on Fruits and Vegetables. Springer

R. Kenneth Horst .2013. Field Manual of Diseases on Garden and Greenhouse Flowers. Springer

Randy C Ploetz.2003. Diseases of Tropical Fruit Crops.CABI

7. AGR13035 Agricultural Marketing, Trade and Prices (L-T-P: 2-0-0) Credit: 2(2+0)

CO-1: to understand the importance of optimization of resource use and output management:

CO-2: Ro understand the methods to enhance the Farm Income.

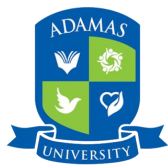
CO-3: To access the factors influencing the growth of Agro-based Industries

CO-4: To understand the needs for adoption and spread of new technology associated with agri marketing

CO-5: To understand the importance of efficient marketing system to national income

CO-6: To understand the importance of Price Signals and its role in economy

Course content



Unit 1: 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,

Unit 2: 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;

Unit 3: Marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark);

Unit 4 : Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread:

Unit 5: 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;

Unit 6: 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;

Unit 7: Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

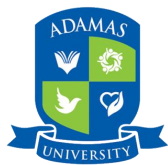
Suggested Reading

James Vercauteren.2011. Agricultural Marketing: Structural Models for Price Analysis. Routledge
W.J. Obst, R. Graham, G. Christie.2007. Financial Management for Agribusiness. CSIRO Publishing
David Van Fleet, Ella Van Fleet, George J. Seperich.2013. Agribusiness: Principles of Management. Cengage Learning
F. Bailey Norwood, Jayson L. Lusk.2018. Agricultural Marketing and Price Analysis. Waveland Press, Inc.
Nilabja Ghosh.2013. India's Agricultural Marketing: Market Reforms and Emergence of New Channels. Springer
Vijay Paul Sharma, Harsh Wardhan.2017. Marketed and Marketable Surplus of Major Food Grains in India. Springer

8. AGR13037 Production Technology of Fruit and Plantation Crops (**L-T-P: 1-0-2**) **Credit: 2(1+1)**

CO.1 -To know importance of different fruit crops and plantation crops.

CO.2- Students will understand canopy architecture for higher productivity in mango and



grapes.

CO.3- Students will understand package of practices for the major crops like mango, banana, guava, lemon, pineapple, coffee, coconut and rubber.

CO.4- To understanding the concept of high density planting in different fruit crops.

Course content

Unit 1: Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks;

Unit 2: Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava,

litchi, papaya, sapota, Mandarins, Black Berry (Jamun), and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

Suggested Reading

Robert E Paull, Odilo Duarte.2010. Tropical Fruits, Volume 1 .CABI

Stewart Bogsan, Cristina, Todorov, Svetoslav Dimitrov.2016. Tropical Fruits: From Cultivation to Consumption and Health Benefits.CABI

Festus K Akinnifesi, Roger B Leakey, Oluyede C Ajayi, Gudeta Sileshi, Zac Tchoundjeu, P Matalcala, F R Kwesiga.2007. Indigenous Fruit Trees in the Tropics.CABI

Jules Janick, Robert E. Paull.2008. The Encyclopedia of Fruit & Nuts.CABI

Rolf Blancke.2016. Tropical Fruits and Other Edible Plants of the World: An Illustrated Guide. Cornell University Press

Dewasish Choudhary, Amal Mehta.2010. Fruit crops. Oxford Book Co.

S. Mohan Jain, P.M. Priyadarshan.2009. Breeding plantation tree crops tropical species. Springer

Thomas M. Gradziel), P.M. Priyadarshan, S. Mohan Jain 2009. Breeding plantation tree crops temperate species. Springer

Jean Nicolas Wintgens.2004. Coffee: Growing, Processing, Sustainable Production: A Guidebook for Growers, Processors, Traders, and Researchers. Wiley-VCH

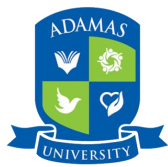
Lucas Louzada Pereira, Taís Rizzo Moreira.2021. Quality Determinants In Coffee Production. Springer

9. AGR13038 Agriculture Engineering II (Irrigation Management) (L-T-P: 1-0-2) Credit: 2(1+1)

CO 1: To take up the basic concepts of irrigation and construction of various hydraulic structures.

CO2: Basic concepts of water, plants, their interactions, as well as irrigation and drainage systems design, planning and management.

CO 3: The structures involved the elementary hydraulic design of different structures and the concepts of maintenance shall also form part.



CO 4: To develop analytical skills relevant to the areas mentioned above, particularly the design of irrigation and drainage projects

Course content

Unit 1: Introduction: Necessity of irrigation- scope of irrigation engineering- benefits and ill effects of irrigation, irrigation development in India- types of irrigation systems, Soil-water plant relationship: Classification of soil water- soil moisture contents- depth of soil water available to plants permanent and ultimate wilting point

Unit 2: Water requirements of crops: Depth of water applied during irrigation- Duty of water and delta improvement of duty command area and intensity of irrigation consumptive use of water and evapotranspiration irrigation efficiencies- assessment of irrigation water

Unit 3: Methods of Irrigation: Classification- choice of method of irrigation- surface and subsurface irrigation methods, Sprinkler and Drip Irrigation

Unit 4 Design of Irrigation Channel: Alignment- canal capacity- losses- FSL of canal- design of canal in alluvial soil and non alluvial soils- Kennedy's silt theory- Lacey's regime theory- balancing depth- use of Garrets diagrams and Lacey's Regime diagrams- lining of irrigation channels- Water logging: Causes, Measures: surface and sub-surface drains, land reclamation

Unit 5: Diversion head works: Types- selection of the suitable site for the diversion headwork components of diversion headwork- Causes of failure of structure on pervious foundation- Khosla's theory- Design of concrete sloping glacis weir

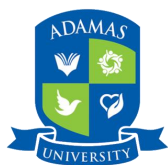
Unit 6 Cross drainage works: Types- selection of suitable type of CD works- aqueduct and Syphon aqueduct determination of maximum flood discharge and waterway for drain, fluming of canal- uplift pressure on underside of barrel roof and at the floor of the culvert- design of bank connections

Unit 7 Canal regulation works: Canal fall- necessity and location- types of falls- Cross regulator and distributary head regulator- their functions, Silt control devices, Canal escapes- types of escapes.

Practical

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different, methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices

Suggested Reading



R. N. Reddy.2010. Irrigation Engineering. Gene-Tech Books
M. H. Ali .2011. Fundamentals of Irrigation and On-farm Water Management: Volume 1. Springer
M. H. Ali .2011. Practices of Irrigation & On-farm Water Management: Volume 2. Springer
Marinus G. Bos, R.A.L. Kselik, Richard G. Allen, David Molden.2008. Water Requirements for Irrigation and the Environment. Springer.
Peter Waller, Muluneh Yitayew.2018. Irrigation and Drainage Engineering. Springer
K. N. Tiwari, N. S. Raghuwanshi.2018. Irrigation Engineering. Indian Council for Agriculture Research.
Dean E. Eisenhauer, Derrel L. Martin, Derek M. Heeren and Glenn J. Hoffman.2021. Irrigation Systems Management. American Society of Agricultural and Biological Engineers (ASABE)
Aliasghar Montazar.2019. Agricultural Irrigation.MDPI
Prem Chandra Jha, Nirajan Devkota.2017. A Textbook of irrigation and drainage engineering . Heritage Publications

10. PSG11021 Human Values & Professional Ethics (L-T-P: 1-0-0) Credit: 1(1+0) * Non Gradial

CO1 Understand the significance of value inputs in a classroom and start applying them in their life and profession.

CO2 Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.

CO3 Understand the value of harmonious relationship based on trust and respect in their life and profession.

CO4 Understand the role of a human being in ensuring harmony in society and nature.

CO5 Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

Course content

Unit 1: Values and Ethics-An Introduction. Goal and Mission of Life. Vision of Life. Principles and Philosophy. Self-Exploration. Self-Awareness. Self-Satisfaction,

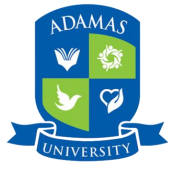
Unit 2: Decision Making, motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

Suggested Reading

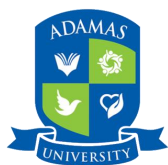
R.S. Naagarazan.2007. A Textbook on Professional Ethics and Human Values. New Age International

D R Kiran.2014. Professional Ethics and Human Values. McGraw-Hill Education

R.R. Gaur, R. Sangal, G.P. Bagaria.2009. A Foundation Course in Human Values and Professional Ethics. Excel Books



SEMESTER V



1. AGR13045 Principles of Organic Agriculture (L-T-P: 2-0-2) Credit: 2(2+1)

CO.1. Initiative from Government for organic produce.

CO.2. Role of NGOs, Farmers club, Farmers Producer Organisation/Companies in producing organic products.

CO.3. Selection of crops and varieties for organic produce

CO.4. Certification of organic produce

Course content

Unit 1: Introduction, concept, relevance in present context; Organic production requirements;

Unit 2: Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers;

Unit 3: Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports.

Practical

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, postharvest management

Suggested Reading

Charles L. Mohler, Sue Ellen Johnson.2009. Crop Rotation on Organic Farms: A Planning Manual. Natural Resource, Agriculture and Engineering Service

C. Sarath Chandran, Sabu Thomas, M. R. Unni.2019. Organic Farming: New Advances Towards Sustainable Agricultural Systems. Springer

Fossil, Peter V.2014. Organic farming : how to raise, certify, and market organic crops and livestock. Voyageur Press

Dilip Nandwani .2016. Organic Farming for Sustainable Agriculture. Springer

Seishu Tojo.2020. Recycle Based Organic Agriculture In A City. Springer

Stéphane Bellon, Servane Penvern .2014. Organic Farming, Prototype for Sustainable Agricultures: Prototype for Sustainable Agricultures. Springer

Eric Lichtfouse.2010. Organic Farming, Pest Control and Remediation of Soil Pollutants. Springer

2. AGR13046 Dryland Agriculture and Watershed Management (L-T-P: 2-0-2) Credit: 2(2+1)

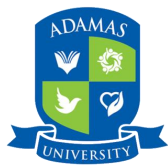
CO.1. Dryland agriculture and its importance in Indian scenario

CO.2. Comprehensive Assessment of Water Management in Agriculture, coordinated by the International Water Management Institute

CO.3 Watershed management techniques

CO.4. Conservation of soil by adopting latest soil conservation techniques

Course content



Unit 1: Dryland agriculture: Introduction, types, History of dryland agriculture & watershed in India; Problems and prospects of dryland agriculture in India ; Soil and climatic conditions prevalent in rainfed areas;

Unit 2 Drought: types, effect of water deficit on physio- morphological characteristics of the plants, Mechanism of crop adaptation under moisture deficit condition;

Unit 3 Water harvesting: importance, its techniques, efficient utilization of water through soil and crop management practices,

Unit 4 Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions.

Unit 5: 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 evapotranspiration 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 Reading

Muhammad Farooq, Kadambot H.M. Siddique .2016. Innovations in Dryland Agriculture.Springer

S P Wani, Johan Rockström, K L Sahrawat.2011. Integrated watershed management in rainfed agriculture.CRC Press

Thomas E. Davenport.2002. The Watershed Project Management Guide. CRC Press

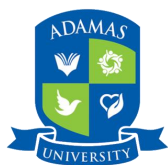
H.M. Schiechl.1993. FAO Watershed Management Field Manual (Vegetative and Soil Treatment Measures).FAO Rome

S. P. Wani, J. Rockstrom, T. Oweis.2009. Rainfed Agriculture: Unlocking the Potential (Comprehensive Assessment of Water Management in Agriculture).CABI

Suhas P. Wani, Johan Rockstrom, Kanwar Lal Sahrawat.2011. Integrated Watershed Management in Rainfed Agriculture.CRC Press

Philip Tow, Ian Cooper, Ian Partridge, Colin Birch, Larry Harrington (auth.), Philip

Tow, Ian Cooper, Ian Partridge, Colin Birch .2011. Rainfed Farming Systems.Springer



3. AGR13047 Crop Improvement II(Fiber,Sugar,Starch, Narcotics, Vegetables, Fruits and Flowers) (L-T-P: 2-0-2) Credit: 3(2+1)

CO-1: Understand the importance of wild relative to produce new varieties of Rabi crop.

CO-2: Understand the importance of conservation of genetic resources associated with the Rabi crops

CO-3: Use of different breeding method to improve the Rabi crops.

CO-4: Acquaint with different genetic approaches to achieve a definite ideotype of Rabi crop

Course content

Unit 1: Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fodder crops and cash crops; vegetable and horticultural crops;

Unit 2: Plant genetic resources, its utilization and conservation; Floral biology, study of genetics of qualitative and quantitative characters;

Unit 3: Important concepts of breeding self-pollinated, cross pollinated and vegetatively propagated crops;

Unit 4: Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability,

Unit 5: Ideotype concept and climate resilient crop varieties for future-abiotic and biotic stress tolerance and breeding for quality (physical, chemical, nutritional);

Unit 6: Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops. Hybrid seed production technology of rabi crops.

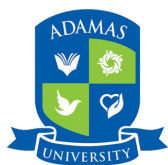
Practical

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 Reading:

Shabir H. Wani, Amita Mohan, Gyanendra Pratap Singh.2021. Physiological, Molecular, and Genetic Perspectives of Wheat Improvement. Springer

Satbir Singh Gosal, Shabir Hussain Wani.2020. Accelerated Plant Breeding, Volume 1: Cereal Crops. Springer



Satbir Singh Gosal, Shabir Hussain Wani.2020. Accelerated Plant Breeding, Volume 2: Vegetable Crops.Springer
Satbir Singh Gosal, Shabir Hussain Wani.2020. Accelerated Plant Breeding, Volume 3: Food crops ,Springer
Satbir Singh Gosal, Shabir Hussain Wani.2020. Accelerated Plant Breeding, Volume 4: Oil Crops. Springer
Antonio M. De Ron .2015. Grain Legumes. Springer
Johann Vollmann, Istvan Rajcan (auth.), Johann Vollmann, Istvan Rajcan.2010. Oil Crops. Springer
Von Mark V. Cruz, David A. Dierig .2015. Industrial Crops: Breeding for BioEnergy and Bioproducts. Springer

4. AGR13048 Principles and Practices of Agricultural Biotechnology (**L-T-P: 1-0-2**) **Credit: 2(1+1)**

CO1. Students will become familiar with the tools and techniques of genetic engineering DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.

CO2. This course exposes students to the applications of genetic engineering in biological research.

CO3. Students will be able to perform basic genetic engineering experiments at the end of course. CO4. Students will acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.

Course content

Unit 1: Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement:

Unit 2: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of In-vitro cultures, Micropropagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture;

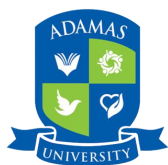
Unit 3: Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids,

Unit 4: Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement. Use of SNP in identification of different variants of crops.

Unit 4: Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples, Nano toxicology and safety.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm



culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer Techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel electrophoresis techniques. Green synthesis of nano particles and their size characterization.

Suggested Reading

Karl-Hermann Neumann, Ashwani Kumar, Jafargholi Imani.2009. Plant cell and tissue culture: a tool in biotechnology: basics and application. Springer

Mohammad Anis, Naseem Ahmad .2015. Plant Tissue Culture: Propagation, Conservation and Crop Improvement. Springer

Oropeza Maira, Mejías Alexander, Teresa Edith Vargas , S. Mohan Jain, Sergio J. Ochoa .2010. Protocols for in vitro propagation of ornamental plants. Springer

Pandey, Prerna, Priyadarshini, Anjali.2019. Biocatalysis and agricultural biotechnology : fundamentals, advances, and practices for a greener future.CRC Press

Dinesh Kumar Srivastava , Ajay Kumar Thakur , Pankaj Kumar.2022 Agricultural Biotechnology: Latest Research and Trends. Springer

Ram Lakhan Singh, Sukanta Mondal.2017. Biotechnology for Sustainable Agriculture: Emerging Approaches and Strategies. Woodhead Publishing

Pablo A. Chong, David J. Newman, Douglas A. Steinmacher.2020. Agricultural, Forestry and Bioindustry Biotechnology and Biodiscovery. Springer

5. AGR13049 Problematic Soils and their Management (L-T-P: 1-0-2) Credit: 2(1+1)

CO1: To provide knowledge about waste land and problematic soils in India and management of the soils.

CO2: Knowledge of different reclamation and management practices for the development of the soils.

CO3: To Understand different factors responsible for saline , sodic and acidic soils and their properties

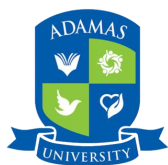
Course content

Unit 1: Study of soil and water resources of Eastern and North Eastern India and India; Collection and reparation of soil, irrigation water, waste water samples;

Unit 2: Study of soil profile; Study of physical constraints in soils Soil crusting: measurement of crust strength; Soil compaction: Study of hard pans in fields;

Unit 3 : Acid soils-Determination of soil pH, EC, Organic carbon, nutrient status, forms of acidity, Estimation of extractable aluminium and CEC, Lime requirement methods; assessment of quality of liming materials; Salt affected soils-

Practical : Determination of soil pH, EC, Organic carbon, nutrient status, CEC, cations and anions, ESP, SAR, Determination of gypsum requirement of alkali soils and assessment of quality of gypsum; Quality of irrigation water-determination of pH, EC, cations and anions, SAR, RSC and interpretation of results; Use of waste water for agriculture-Determination of pH, EC, anions, cations; Determination of DO, BOD and COD; Visits to problematic soil areas-to see the fields affected by salinity, sodicity, acidity and control measures taken up; Visits to soil health laboratories.



Suggested Readings:

Khan Towhid Osman.2018.Management of Soil Problems. Springer
Pedro A. Sanchez.2019. Properties and Management of Soils in the Tropics. Cambridge University Press
A. Monem Balba.2018. Management of Problem Soils in Arid Ecosystems. Chapman and Hall
K C Manorama Thampatti.2022. Problem Soils: Constraints and Management.CRC Press

6. AGR13050 Principles of Integrated Pest and Disease Management (L-T-P: 1-0-2) Credit: 2(1+1)

CO 1: Students are skilled in determining pest levels and impact on plant and animal hosts and the management of these pests by Integrated Pest Management approach.

CO 2: To be able to address complex problems facing entomology or toxicology professionals taking into account related ethical, social, legal, economic, and environmental issues.

CO 3: To be able to surveillance and forecasting of insect pests and assessment of insect pest population and recent pest outbreaks and manage them by using different tools and recent methods pest management.

CO 4: To Understands about different classes of insecticides, their formulation, toxicity, poisoning, first aid and antidotes and their effect on plants, animals and environment.

Course content

Unit 1: 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.

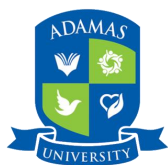
Unit 2: Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level.

Unit 3: Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management.

Unit 4: 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. Case histories of important IPM programmes.

Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of *Trichoderma*, *Pseudomonas*, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agroecosystem) dynamics of a selected insect pest and diseases. Plan & assess preventive strategies (IPM module) and decision making. crop monitoring attacked by insect, pest and diseases .Awareness campaign at farmers' fields.



Suggested reading

- Paul A. Horne, Jessica Page.2008. Integrated Pest Management for Crops and Pastures.CSIRO Publishing
- D P Abrol, Uma Shankar.2012. Integrated pest management: principles and practice.CABI
- P. Parvatha Reddy.2014. Biointensive Integrated Pest Management in Horticultural Ecosystems. Springer
- David Pimentel, Rajinder Peshin.2014. Integrated Pest Management: Pesticide Problems, Vol.3. Springer
- David Pimentel, Rajinder Peshin.2014. Integrated pest management. Vol. 4, Experiences with implementation, global overview. Springer
- A. Ciancio, A. Ciancio, K.G. Mukerji.2007. General concepts in integrated pest and disease management. Springer
- D P Abrol.2014 Integrated pest management: current concepts and ecological perspective. Academic Press
- Rangaswamy Muniappan, E. A. Heinrichs.2016. Integrated Pest Management of Tropical Vegetable Crops. Springer
- Cocuzza, Giuseppe E. Massimino, Rapisarda, Carmelo.2018. Integrated pest management in tropical regions.CABI
- Crain, Philip R., Onstad, David W.2020. The Economics of integrated pest management of insects.Springer

7. AGR13051 Farm Management, Production and Resource Economics (L-T-P: 1-0-2) Credit: 2(1+1)

CO-1: The course contains a comprehensive treatment of the traditional agricultural production economics topics employing both detailed graphics and differential calculus.

CO-2: Focus on the neoclassical factor-product, factor-factor and product- product models, and is suitable for an advanced undergraduate or a beginning graduate –level course in static production economics.

CO-3: Understand limited resources available in the economy. Realize the need to exploit and utilize through development and improvement of production techniques.

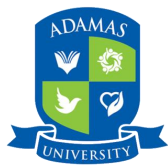
CO-4:Make them aware of the availability of rich natural endowments to achieve sustainable agricultural development with this knowledge they can challenge the problems of unemployment inequality shortage of food productions , poverty and be useful to compete advanced agricultural economies.

CO-5:Gain knowledge of the causes of regional variations in productivity and production, social and economic inequality, size of land holdings and lack of quality inputs etc. And suggest appropriate measures for the whole economy.

Course content

Unit 1: 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.

Unit 2: Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage.



Unit 3: 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 labour income and farm business income.

Unit 4: Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. 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.

Unit 5: Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises.

Unit 6: Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies, Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources. Positive and negative externalities in agriculture, Inefficiency and welfare loss, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. 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. Collection and analysis of data on various resources in India

Suggested Reading

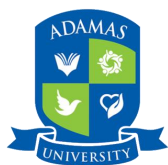
- Peter L Nuthall.2011. Farm Business Management: Analysis of Farming Systems.CABI
Peter L. Nuthall.2010. Farm Business Management: The Core Skills.CABI
Peter L. Nuthall.2018. Farm Business Management: The Human Factor, 2nd Ed .CABI
Patricia A. Duffy, William M. Edwards, Ronald D. Kay.2016. Farm Management. McGraw-Hill
Ronald Kay, William Edwards, Patricia Duffy.2019. Farm Management. McGraw-Hill Education
Halachmi, Ilan.2015. Precision livestock farming applications: making sense of sensors to support farm management. Wageningen Academic Publishers
Ronald Kay, William Edwards, Patricia Duffy.2011. Farm Management. McGraw-Hill Education
Nobuyoshi Yasunaga, Norikazu Inoue.2020. Farm and Rural Community Management in Less Favored Areas.Springer

8. AGR11052 Entrepreneurship Development and Business Communication (L-T-P: 2-0-0) Credit: 2(2+0)

CO1 Define basic terms, Analyse the business environment in order to identify business opportunities,

CO2 Identify the elements of success of entrepreneurial ventures,

CO3 Consider the legal and financial conditions for starting a business venture,



- CO4 Evaluate the effectiveness of different entrepreneurial strategies,
- CO5 Specify the basic performance indicators of entrepreneurial activity,
- CO6 Explain the importance of marketing and management in small businesses venture,
- CO7 Interpret their own business plan

Course content

Unit 1: Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development, Impact of economic reforms on Agribusiness/ Agrienterprises,

Unit 2: Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills),

Unit 3: 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, 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 institute and entrepreneurs.

Suggested Reading

Chan, Catherine, Lee, Tina, Sipes, Brent Steven.2017. Enabling agri-entrepreneurship and innovation : empirical evidence and solutions for conflict regions and transitioning economies.CABI

Poornima M Charantimath.2005. Entrepreneurship Development & Small Business Enterprises. Pearson Education

Bruce R. Barringer, R. Duane Ireland.2016. Entrepreneurship: Successfully Launching New Ventures. Pearson

Bruce R. Barringer, Duane Ireland.2011. Entrepreneurship: Successfully Launching New Ventures, 4th Ed. Prentice Hall.

Mary Guffey.2016. Essentials of Business Communication. Cengage Learning

Mary Ellen Guffey, Dana Loewy.2019. Essentials of business communication. Cengage learning

9. AGR13053 Production Technology of Ornamental Crops, MAP and Landscaping L-T-P: 1-0-1) Credit: 2(1+1)

CO.1- To evaluate natural herbal products from an economic perspective.

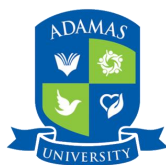
Co.2-To use medicinal and aromatic herbs sustainably.

CO.3-To set up business related to medicinal, aromatic and landscaping.

CO.4-To develop effective ideas related to collecting, processing and marketing herbal natural sources

Course content

Unit 1: Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping.Principles of landscaping. Landscape uses of trees, shrubs and climbers.



Unit 2: Production technology of important cut flowers like rose, gerbera, carnation, liliun and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions.

Unit 3: Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver.

Unit 4: 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.

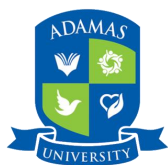
Suggested Reading

Johan Van Huylenbroeck.2018. Ornamental Crops. Springer
Donald McEwan Alexander, William J. Lewis.2009. Grafting and Budding: A Practical Guide for Fruit and Nut Plants and Ornamentals.CSIRO Press
C. Damiano.2000. Ornamental Plant Propagation in the Tropics .FAO,Rome
Oropeza Maira, Mejías Alexander, Teresa Edith Vargas , S. Mohan Jain, Sergio J. Ochatt .2010. Protocols for in vitro propagation of ornamental plants.Springer Protocols
Sukhdev Swami Handa, Suman Preet Singh Khanuja, Gennaro Longo, Dev Dutt Rakesh.2008. Extraction Technologies for Medicinal and Aromatic Plants .International Center for Science and High Technology.
Anand Akhila.2009. Essential Oil-Bearing Grasses: The genus Cymbopogon. Taylor & Francis
Mohamed Neffati, Hanen Najjaa, Ákos Máthé .2017. Medicinal and Aromatic Plants of the World - Africa Volume 3.Springer
Ákos Máthé .2015. Medicinal and Aromatic Plants of the World: Scientific, Production, Commercial and Utilization Aspects.Springer
C.P. Khare.2007. Indian Medicinal Plants: An Illustrated Dictionary.Springer
D. K. Sharma.2008. Horticultural, medicinal and aromatic plants. Book Enclave
Mary Pratt.2005. Practical Science for Gardeners. Timber Press Incorporated
Francesco Orsini, Marielle Dubbeling, Henk de Zeeuw, Giorgio Gianquinto.2017. Rooftop Urban Agriculture.Springer
Dilip Nandwani.2018. Urban Horticulture.Springer
Blum, Janaki.2016. Urban horticulture: ecology, landscape, and agriculture. Apple Academic Press
Chris Peterson.2011. Black & Decker The Complete Guide to a Better Lawn How to Plant, Maintain & Improve Your Yard & Lawn. Creative Publishing

10. AGR13054 Protected Cultivation and Greenhouse Management Landscaping L-T-P: 1-0-1) Credit: 2(1+1)

CO-1: To get knowledge about greenhouse technology, types of green houses and construction of green houses.

CO-2: Course will give the knowledge of Greenhouse equipment's, materials of construction for traditional and low cost green houses.



CO-3: This course will help the students to learn about Irrigation systems used in greenhouses, shade net house in protected cultivation.

CO-4: By this course student get the concepts of disease and pest management under protected cultivation.

Course content

Unit 1: Protected cultivation- importance and scope, Status of protected cultivation in India and World types of protected structure based on site and climate.

Unit 2: Cladding material involved in greenhouse/ poly house. Greenhouse design, environment control, artificial lights, Automation. Soil preparation and management, Substrate management. Types of benches and containers. Irrigation and fertigation management.

Unit 3: Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops – rose, carnation, chrysanthemum, gerbera, orchid, anthurium, liliium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants, etc.

Unit 4: Cultivation of economically important medicinal and aromatic plants. Off-season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, use of protrays in quality planting material production, Bed preparation and planting of crop for production, Inter cultural operations, Soil EC and pH measurement, Regulation of irrigation and fertilizers through drip, fogging and misting.

Suggested Reading

P. Parvatha Reddy.2016. Sustainable Crop Protection under Protected Cultivation.Springer

Lynette Morgan.2021. Hydroponics and Protected Cultivation: A Practical Guide.CABI
Gerrit van Straten, E.J. van Henten, L.G. van Willigenburg, R.J.C. van Ooteghem.2010. Optimal Control of Greenhouse Cultivation.CRC Press

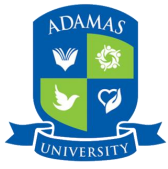
Nicolás Castilla.2013. Greenhouse technology and management.CABI

Pedro Ponce, Arturo Molina, Paul Cepeda, Esther Lugo, Brian MacCleery.2014. Greenhouse Design and Control.CRC Press

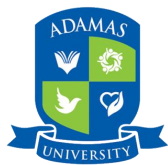
Cees Sonneveld, Wim Voogt .2009. Plant Nutrition of Greenhouse Crops.Springer

Roger Marshall.2006. How to build your own greenhouse: designs and plans to meet your growing needs.Storey Publishing House

Cloyd, Raymond A.2016. Greenhouse pest management.CRC Press



SEMESTER VI



1. AGR13062 Remote Sensing, Drones and their Application in Agriculture **L-T-P: 2-0-1)**
Credit: 3(2+1)

CO1: To understand the importance of remote sensing in modern day agriculture

CO2: To understand the methods of deciphering the data obtained from the satellites

CO3: To assess the importance of Agricultural drones and the functionality

CO 4: To operate the drones used in agriculture and allied sciences

Course content

Unit 1: Introduction to principles of spectroscopy, different types of sensors used in biological sciences and agriculture, introduction to basic sensing concepts, remote sensing, proximal sensing systems.

Unit 2: Basic sensing systems in precision agriculture, remote sensing for precision agriculture, multispectral satellites.

Unit 3: Sensing crop geometry and structures, photogrammetric techniques, structures from motion and multiview stereo, ultrasonic sensors, photoelectric sensors, LiDAR sensors, depth cameras structured light sensors, time of flight cameras..

Unit 4: Proximal soil sensing technologies, interpretation of soil sensor data, principles of digital soil mapping, Concepts of wireless sensing networks and its application in agriculture, uses of wireless sensing networks in irrigation, fertilizer application, pest management, crop monitoring,

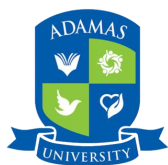
Unit 5: Sensors for decision support systems for irrigation, diseases and crop health monitoring to estimate pre and post-harvest losses, assessing grain quality using Near Infra-red spectroscopy, optical sensors for crop density, height and canopy cover, precision techniques for nitrogen management, grain segregation in the combine harvester's, detection of post-harvest stress in grains, weed detection and mapping techniques. Visible and near infra-red bands for stress detection.

Practical

Use of data loggers for assessing the different environmental parameters, use of soil sensors to access the different parameters, use of infra-red sensors and cameras to access crop health .

Suggested reading

Ruth Kerry and Alexandre Escolà (Eds) 2021 Sensing Approaches for Precision Agriculture. Springer Nature



Sigfredo Fuentes, Ranjith R Unnithan, Eden Tongson, Nir Lipovetzky (Editors)2021. Implementation of Sensors and Artificial Intelligence for Environmental Hazards Assessment in Urban, Agriculture and Forestry Systems. MDPI

Rajesh Singh, Anita Gehlot, Mahesh Kumar Prajapat, Bhupendra Singh.2021. Artificial Intelligence in Agriculture. CRC Press

Utku Kose, V. B. Surya Prasath, M. Rubaiyat Hossain Mondal, Prajoy Podder, Subrato Bharati.2022. Artificial Intelligence and Smart Agriculture Technology Auerbach Publications

Govind Singh Patel, Amrita Rai, Nripendra Narayan Das, R.P. Singh. 2021. Smart Agriculture: Emerging Pedagogies of Deep Learning, Machine Learning and Internet of Things.CRC Press

Pradeep Tomar and Gurjit Kaur.2021. Artificial Intelligence and Iot-based Technologies for Sustainable Farming and Smart Agriculture. Engineering Science Reference

2. **AGR13063 Farming System and Sustainable Agriculture (L-T-P: 1-0-1) Credit: 2(1+1)**

CO1 The student will be able to explain the major aspects of agricultural practices and traditions through time and throughout the world.

CO2 The student will be able to explain in general the relationships among culture, economics, politics, science, and agricultural development.

CO3 A solid understanding of the cross-cultural interactions and exchange that linked the world's people and facilitated agricultural development is also expected.

CO4 The student will study and analyze the refereed-journal articles, texts, and practices that represent the perspectives of different societies and agricultural traditions.

CO5 To show how agricultural scientists are attempting to minimize agricultural pollution and sustain food production adequate for the world's population.

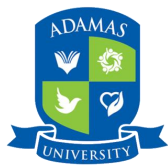
Course content

Unit 1: Sustainable agriculture- definition, concept, goals; factors affecting ecological balance- land degradation, water and air pollution, global warming, impact and amelioration; sustainable agriculture practices-natural farming, alternative farming, integrated farming. HEISA, LEISA and BIOFARMS.

Unit 2: Farming systems– principles, concepts, components; cropping systems; sequential cropping, crop rotation, relay and ratoon cropping, multistory cropping, filler and inter planting in orchards;

Unit 3: Assessment of multiple cropping advantages; delineation of efficient cropping zones based on RYI and RSI and strategies for improving crop productivity in different zones; IFS models for dry, wet, wastelands and for different agro climatic situations.

Unit 4: Definition of precision agriculture scope and concept of precision agriculture, components of precision agriculture. Global Positioning System (GPS), Geographic Information System (GIS), Computer software model and remote sensing for aerial/satellite imagery.



Unit 5: Site Specific Nutrient Management (SSM) for nutrient and irrigation management practices. Comparative yield, quality and farm profits under SSM practices V/s Uniform Rate Technology (URT) practices.

Practical

Assessment of multiple cropping advantages and sustainability; Preparation of cropping schemes for rainfed situations, Preparation of cropping schemes for irrigated situations; Preparation of Integrated Farming System (IFS) models for rainfed and irrigated lands; Preparation of IFS models for wet and wastelands; Resource allocation and management of dairy, poultry, piggery, sericulture as a component of IFS; Labour resource management, labour saving techniques, farm records and farm book keeping; Indigenous technical knowledge in organic farming; Preparation and use of botanicals in organic farming; Processing. Certification and accreditation in organic farming.

Suggested Reading

Francisco J. Villalobos, Elias Fereres.2016. Principles of Agronomy for Sustainable Agriculture.Springer

Chikoye, David, Gondwe, Therese, Nhamo, Nhamo.2017. Smart technologies for sustainable smallholder agriculture : upscaling in developing countries.Academic Press

Jochen Bundschuh, Guangnan Chen.2014. Sustainable Energy Solutions in Agriculture.CRC Press

Mohamed Behnassi, Sanni Yaya , Mohamed Behnassi, Shabbir A. Shahid, Joyce D'Silva .2011. Sustainable Agricultural Development: Recent Approaches in Resources Management and Environmentally-Balanced Production Enhancement.Springer

Food and Agriculture Organization of the United Nations.2020. Enabling sustainable food systems.FAO Rome

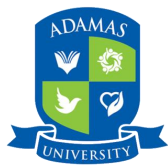
Bhoopander Giri, Ram Prasad, Qiang-Sheng Wu, Ajit Varma.2019. Biofertilizers for Sustainable Agriculture and Environment.Springer

D. Little.2004. Integrated Livestock-Fish Farming Systems Animals Pets.FAO Rome.

Megh R Goyal.2018. Sustainable Biological Systems for Agriculture: Emerging Issues in Nanotechnology, Biofertilizers, Wastewater, and Farm Machines. Apple Academic Press

Yash P. Dang, Ram C. Dalal, Neal W. Menzies.2020. No-till Farming Systems for Sustainable Agriculture: Challenges and Opportunities.Springer

Philip Tow, Ian Cooper, Ian Partridge, Colin Birch, Larry Harrington , Philip Tow, Ian Cooper, Ian Partridge, Colin Birch .2011. Rainfed Farming Systems.Springer



Ika Darnhofer, David Gibbon, Benoit Dedieu, Ika Darnhofer, David Gibbon, Benoît Dedieu.2012. Farming Systems Research into the 21st Century: The New Dynamic.Springer

Dennis J. Timlin, Saseendran S. Anapalli.2022. Enhancing Agricultural Research and Precision Management for Subsistence Farming: By Integrating System Models with Experiments.Wiley

3. AGR13064 Fundamentals of Robotics, Artificial Intelligence & Machine Learning in Agriculture (**L-T-P: 1-0-1**) **Credit: 2(1+1)**

CO 1: Understand the importance of Artificial intelligence and machine learning in modern day agriculture

CO 2: To be appraised about the importance of automation in modern day agriculture and allied sciences

CO3: To understand the operations of the robotic equipment as applied to agriculture and allied sciences and their advantages and limitations

Course content

Unit 1: Fundamental technologies for agricultural and field robotics: sensing and situation awareness, intelligent decision making, basics of color imaging, color representation, RGB, HLS and HSV models, CIELAB and CIELUV models, color space comparison, comparison of colors.

Unit 2: Techniques of image acquisition, 3D measuring principles, 3D from 2D images, stereo vision systems, depth estimation using stereo vision camera and their calibration techniques, imaging correspondence tools used for stereo vision based distance measurement, use of Laser and LIDAR for visual servoing,.

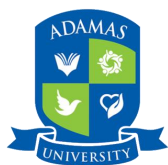
Unit 3: Global navigation satellite systems, basis's of spectral imaging and data analysis, crop scouting and surrounding awareness of speciality crops.

Unit 4: Fundamentals of Machine learning, deep learning similarities and dissimilarities, deep neural networks, tools for agriculture operations, transfer learning for pest detection, crop yield detection, E mandhi using machine learning, monitoring agricultural inputs using ML and DL tools, ML based remote monitoring tools for agri farm monitoring, intelligent farming systems based on weather forecast

Practical

Robotic manipulation and optimization for agricultural operations, end effector technologies, control techniques for robotic harvesting

Suggested Reading



Mohammad Shorif Uddin , Jagdish Chand Bansal 2021. Computer Vision and Machine Learning in Agriculture. Springer
Manoj Karkee, Qin Zhang.2021. Fundamentals of Agricultural and Field Robotics. Springer Nature.
Avital Bechar.2021. Innovation in Agricultural Robotics for Precision Agriculture: A Roadmap for Integrating Robots in Precision Agriculture. Springer
Mohammad Ayoub Khan, Rijwan Khan, Mohammad Aslam Ansari.2022. Application of Machine Learning in Agriculture. Elsevier

4. **AGR11065 Intellectual Property Rights (L-T-P: 1-0-0) Credit: 1(1+0)**

CO 1: To be skilled to understand the concept of intellectual property rights.
CO2. To obtain procedural knowledge to Legal System and solving the problem relating to intellectual property rights.
CO 3. To be skilled in order understand the professional programs agricultural and allied sciences.

Course content

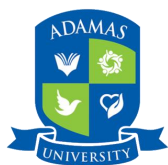
Unit 1: Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.
Unit 2: Types of Intellectual Property and legislations covering IPR in India:-Patents, Copyrights, Trademark, 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.
Unit 3: 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 and livestock breeders rights, Registration of plant and livestock varieties under PPV&FR Act 2001, breeders, researcher and farmers rights.
Unit 4 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.

Suggested Reading

Vittorio Santaniello, Robert E Evenson, David Zilberman, Gerald A Carlson.2000. Agriculture and intellectual property rights: economic, institutional and implementation issues in biotechnology.CABI
Chandan Roy.2018. The Role of Intellectual Property Rights in Agriculture and Allied Sciences. Apple Academic Press.
Frederic H Erbisich, Karim M Mareid.2004. Intellectual property rights in agricultural biotechnology.CABI

5. **AGR13066 Management of Agriculturally Beneficial Insects(L-T-P: 1-0-0) Credit: 1(1+0)**

CO 1: To understand the life cycle of different beneficial insects viz. honey bees, lac insects, silk worm etc.



CO 2: To understand commercial methods of rearing, equipment, seasonal management, insect pest and disease and important species for commercial use of honey bee, silkworm and lac insect.

CO 3: Identification of different bio control agents (Predator, Parasite and Parasitoids) and their use for sustainable pest management.

CO 4: Learn about mass multiplication technique of biological control agents and established a bio control lab.

Course content

Unit 1: Introduction to beneficial insects. Importance and History of apiculture. Species of honey bees, Rock bee, little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination.

Unit 2: Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons,

Unit 3: Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues. Importance, History and development in India, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipment's, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs.

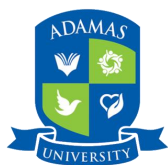
Unit 4: Silkworm rearing young age /chawki rearing and old age rearing of silkworms. Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products.

Unit 5: Economics of silk production. Moriculture Mulberry varieties, package of practices, Pests and diseases and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.

Practical

Honey bee colony, different bee hives and apiculture equipment. Summer and winter management of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions. Maintenance of mulberry garden- pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipment's for silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

Suggested Reading



David V Alford.2019. Beneficial Insects.CRC Press

Hoffman Black, Scott, Hopwood, Jennifer, Lee-Mäder, Eric, Morandin, Lora, Vaughan, Mace. , .2014. Farming with native beneficial insects : ecological pest control solutions

Gardiner, Mary M.2019. Good garden bugs: everything you need to know about beneficial predatory insects.Quarry.

Rosefiend Cordell.2021. Beneficial and Pest Insects: The Good, the Bad, and the Hungry. Rosefiend Publishing

Juan A. Morales-Ramos, M. Guadalupe Rojas, David I. Shapiro-Ilan.2021. Mass Production of Beneficial Organisms: Invertebrates and Entomopathogens.Academic Press

6. **AGR13067 Geo-informatics and Nanotechnology for Precision Farming (L-T-P: 1-0-1) Credit: 2(1+1)**

CO.1: The student will be able to understand the concept of variable rate technology and its importance in agriculture.

CO.2: The student will be able to effective use of inputs results in optimizing crop yield and/or quality, without polluting the environment.

CO.3: Precision agriculture can address both economic and environmental issues that surround production agriculture today.

CO.4: Encourage the farmers to study of spatial and temporal variability of the input parameters using primary data at field level.

CO.5: Creating awareness amongst farmers about consequences of applying imbalanced doses of farm inputs like irrigation, fertilizers, insecticides and pesticides.

Course content

Unit 1: Precision agriculture: concepts and techniques; their issues and concerns for tropical and Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture.

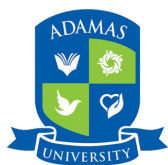
Unit 2: Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Remote sensing concepts and application in agriculture; Image processing and interpretation; Global positioning system (GPS), NavIC components and its functions;

Unit 3: Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs; STCR approach for precision agriculture;

Unit 4: Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects, nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in 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 Reading

Mohammed Faizan O.2020. Geoinformatics Handbook.

Hesham El-Askary, Zeynal Abiddin Erguler, Murat Karakus, Helder I. Chaminé.2021.Research Developments in Geotechnics, Geo-Informatics and Remote Sensing. Springer

Pavan Kumar, Haroon Sajjad, Bhagwan Singh Chaudhary, J. S. Rawat, Meenu Rani.2021. Remote Sensing and GI Science : Challenges and Future Directions. Springer.

Maged Marghany.2022. Remote Sensing and Image Processing in Mineralogy.CRC press

Huete, Alfredo, Lyon, John G., Thenkabail, Prasad Srinivasa.2018. Remote sensing of vegetation. Hyperspectral indices and image classifications for agriculture and vegetation.CRC press

Javid A. Parray, Mohammad Yaseen Mir, Nowsheen Shameem.2021 Nano–Technological Intervention in Agricultural Productivity. Wiley

Huete, Alfredo, Lyon, John G., Thenkabail, Prasad S.2019. Hyperspectral remote sensing of vegetation. Volume IV, Advanced applications in remote sensing of agricultural crops and natural vegetation. CRC press

7. **AGR13068 Computer Applications and Agriculture Informatics (L-T-P: 1-0-1)** **Credit: 2(1+1)**

CO 1: Understand analogy of computer

CO 2: Basic knowledge of MS Office and Linux

CO 3: Some basic knowledge of Internet and WWW

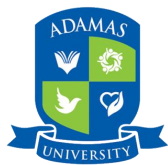
CO 4: Use of IT application and different IT tools in Agriculture

CO 5: Use of Decision support systems, Agriculture Expert System and Soil Information Systems in Agriculture

Course content

Unit 1:Applications of MS-Office for creating, editing and formatting a document; Data presentation, tabulation and graph creation; Statistical analysis, mathematical expressions; Database, concepts and types, creating database; Uses of DBMS in Agriculture; Internet and World Wide Web (WWW), concepts, components and creation of web; HTML & XML coding.

Unit 2: Computer programming, concepts; Documentation and programme maintenance; Debugging programmes; Introduction to Visual Basic, Java, Fortran, C/ C++, etc.; Standard input/output operations; Variables and constants; Operators and expressions;



Unit 3 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;

Unit 4: Formation of development programmes, monitoring and evaluation; Computer models in agriculture: statistical, weather analysis and crop simulation models - concepts, structure, input-output files, limitations, advantages and application for understanding plant processes, sensitivity, verification, calibration and validation; IT application for computation of water and nutrient requirement of crops; Unit 5. Computer-controlled devices (automated systems) for agrinput management; Smartphone mobile apps in agriculture for farm advice, market price, postharvest management, etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information; Decision support systems, taxonomy, components, framework, classification and applications in agriculture; Agriculture Information/Expert System; Soil Information Systems, etc. for supporting farm decisions; Preparation of contingent crop planning and crop calendars using IT tools.

Practical

Introduction to World Wide Web (WWW) and its components. Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost. Preparation of Inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology, for generating information important for Agriculture. Hands on practice on preparation of Decision Support System. Preparation of contingent crop planning

Suggested reading

Amitava Choudhury, Arindam Biswas, Manish Prateek, Amlan Chakrabarti.2021. Agricultural Informatics: Automation Using the IoT and Machine Learning (Advances in Learning Analytics for Intelligent Cloud-IoT Systems). Wiley-Scrivener
Information Resources Management Association.2019. Environmental and Agricultural Informatics: Concepts, Methodologies, Tools, and Applications. Engineering Science Reference
Prasant Kumar Pattnaik, Raghvendra Kumar, Souvik Pal, S. N. Panda.2020. IoT and Analytics for Agriculture. Springer Singapore

8. **AGR13069 Post-harvest Management and Value-addition of Fruits, Flowers and Vegetables (L-T-P: 1-0-1) Credit: 2(1+1)**

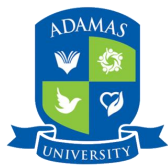
Co.1- Understand the post-harvest technology of horticultural crops.

Co.2- Understand the value addition of horticulture crops.

Co.3-U the work space, tool and equipment design for PHT and value addition.

Co.4- study the various certification and accreditation i.e. FPO, ISO and other leveling.

Course content



Unit 1: Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture),

Unit 2 Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic),

Unit 3: Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration, Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, microorganisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables,

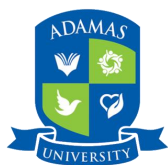
Unit 4: Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables,

Unit 5: Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers, Quality control in fruit and vegetable processing industry. Food supply chain.

Practical

Performance evaluation of peeler and slicer, Performance evaluation of juicer and pulper, Performance evaluation of blanching equipment, Testing adequacy of blanching, Study of cold storage and its design, Study of CAP and MAP storage, Minimal processing of vegetables, Preparation of value added products, Visit to fruit and vegetable processing industry, Visit to spice processing plant.

Suggested Reading



Tzia, Constantina, Varzakas, Theodoros.2016. Handbook of food processing : food safety, quality, and manufacturing processes.CRC Press

Y. H. Hui, Sue Ghazala, Dee M. Graham, K.D. Murrell, Wai-Kit Nip.2003. Handbook of Vegetable Preservation and Processing (Food Science and Technology). Marcel Dekker

P. Zeuthen.2003 Food Preservation Techniques.CRC Press

Brennan J.G., Grandison A.S.2019. Food Processing Handbook (Vol. 1 and 2). Wiley Press

Amit Baran Sharangi, Suchand Datta .2015. Value Addition of Horticultural Crops: Recent Trends and Future Directions. Springer

Sankar Chandra Deka, Dibyakanta Seth, Nishant Rachayya Swami Hulle.2020. Technologies for Value Addition in Food Products and Processes. Apple Academic Press

Mohammed Wasim Siddiqui, Asgar Ali.2016. Postharvest management of horticultural crops: practices for quality preservation. Apple Academic Press

Khursheed Alam Khan, Megh R. Goyal, Abhimannu A Kalne.2019. Processing of Fruits and Vegetables: From Farm to Fork. Apple Academic Press

Goyal, Megh Raj, Khan, Khursheed A., Paul, Prodyut K., Sehrawat, Rachna.2018. Technological Interventions in the Processing of Fruits and Vegetables. Apple Academic Press

9. AGR13070 Renewable Energy and Green Technology (**L-T-P: 1-0-1**) **Credit: 2(1+1)**

CO1: To understand the role of renewable sources in agriculture sector.

CO2: To understand the bio fuel production and their applications in today's world.

CO3: To understand and utilizing the solar energy in various aspects.

Course content

Unit 1: Classification of energy sources, contribution of these of sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application,

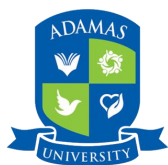
Unit 2: Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and bio oil production and their utilization as bioenergy resource, introduction of solar energy, collection and their application,

Unit 3: 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 and solar pond

Suggested Reading



Imene Yahyaoui.2018. Advances in Renewable Energies and Power Technologies: Volume 1: Solar and Wind Energies. Elsevier
Robert Ehrlich, Harold A. Geller.2018. Renewable Energy, Second Edition: A First Course. Taylor & Francis, CRC Press
G. N. Tiwari, Arvind Tiwari, Shyam.2016. Handbook of Solar Energy: Theory, Analysis and Applications.Springer
Volker Quaschnig.2005. Understanding Renewable Energy Systems. Earthscan Publications Ltd.
Vladimir Strezov , Hossain Md. Anawar .2019. Renewable Energy Systems from Biomass: Efficiency, Innovation, and Sustainability.CRC Press
Arthur Wellinger, Jerry Murphy, David Baxter.2013. The biogas handbook: Science, production and applications.Woodhead Publishing
Mario Alejandro Rosato.2018. Managing Biogas Plants: A Practical Guide.CRC Press
Helen Treichel, Gislaine Fongaro.2019. Improving Biogas Production: Technological Challenges, Alternative Sources, Future Developments.Springer
Meisam Tabatabaei, Hossein Ghanavati.2018. Biogas. Springer

10. AGR11071 Principles of Food Science and Nutrition (**L-T-P: 2-0-0**) **Credit: 2(2+0)**

CO.1- To understand the importance of different nutrients and the deficiencies arising from the deficiency of the same

CO.2- Discuss the important pathogen and spoilage microorganism in foods.

CO.3- Discuss basic principles and practices of cleaning and sanitation in food preparation operation.

CO.4- Identify and explain nutrients in foods and the specific functions in maintaining health.

Course content

Unit 1: Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.);

Unit 2: Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives and important reactions);

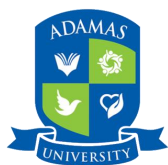
Unit 3: Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods);

Unit 4: Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.);

Unit 5 Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/ modified diets, Menu planning, New trends in food science and nutrition.

Suggested Readings

Romain Jeantet, Thomas Croguennec, Pierre Schuck, Gérard Brulé.2016. Handbook of Food Science and Technology 1: Food Alteration and Food Quality. Wiley-ISTE



Romain Jeantet, Thomas Croguennec, Pierre Schuck, Gérard Brule.2016. Handbook of Food Science and Technology 2: Food Process Engineering and Packaging. Wiley-ISTE
ohn M. deMan, John W. Finley, W. Jeffrey Hurst, Chang Yong Lee,2018. Principles of Food Chemistry.Springer
Shen, Cangliang, Zhang, Yifan.2017. Food microbiology laboratory for the food science student : a practical approach. Springer
Geoffrey Campbell-Platt.2017. Food Science and Technology. Wiley-Blackwell
Vickie Vaclavik, Elizabeth W. Christian, Tad Campbell.2021. Essentials of Food Science.

Springer

11. AGR13072 Environmental Studies and Disaster Management (L-T-P: `1-0-1) Credit: 2(1+1)

CO1: The student will be able to appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving.

CO2: Ecosystem Links between environmental components and their role and types of ecosystems.

CO3: Current problems related issues context in solving environmental issues such as environmental health, food and agriculture, energy, waste and pollution, climate change, management

CO4: Types of natural disasters viz. Floods, forest fires, drought, cyclones, etc. and their effect on the society and methods to mitigate the short and long term consequences of the same.

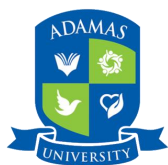
Course content

Unit 1: Environmental Studies: Scope and importance. Natural Resources: Renewable and non-renewable resources Natural resources and associated problems.

Unit 2: Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global.

Unit 3:National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies.

Unit 4: 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.

Unit 5: 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.

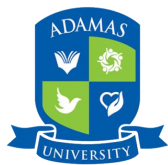
Unit 6. Natural Disasters and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters Nuclear disasters, chemical 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

Case Studies and 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. Expected impact of climate change on agricultural production and water resources, Mitigation Strategies, Economics of climate change. Disaster Management introduction, Natural and Manmade Disaster Studies, Informatics for Disaster Management, Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.

Suggested Reading

- Eldon D. Enger, Bradley F. Smith.2015. Environmental Science: A Study of Interrelationships. McGraw-Hill Education
- Daniel B. Botkin, Edward A. Keller.2010. Environmental Science: Earth as a Living Planet, 8th Edition. Wiley
- Susan Karr, Jeneen Interlandl, Anne Houtman.2015. Environmental Science for a Changing World. W. H. Freeman
- Pamela Walker, Elaine Wood.2010. Environmental science experiments
- Anil Kumar De, Arnab Kumar De.2007. Environmental Studies. New Age Publications
- Kaushik, Anubha., Kaushik, C. P.2006. Perspectives in Environmental Studies. New Age Publications
- Eldon D. Enger, Bradley Smith.2009. Environmental Science: A Study of Interrelationships, 12th Edition. McGraw-Hill Higher Education
- Shashi Chawla.2012. A Textbook of Environmental Studies. Mc Graw Hill
- Anindita Basak.2015. Environmental Studies. Pearson Education
- Amita Singh, Milap Punia, Nivedita P. Haran, Thiyam Bharat Singh.2018. Development and Disaster Management.Springer



Huong Ha, R. Lalitha S. Fernando, Amir Mahmood.2015. Strategic Disaster Risk Management in Asia.Springer

12. AGR11073 Agriculture Supply Chain Management and Warehousing (L-T-P: `1-0-0) Credit: 1(1+0)

CO 1: The student will be appraised with the different supply mechanisms related to agriculture products

CO2: The students will be able to understand the weakest link in agriculture supply and the methods to improve the same to minimize post-harvest losses

CO3: The students will be able to understand the importance of modern environmental controlled ware houses and its role in minimizing post-harvest losses of agricultural products

Course content

Unit-I: Overview of logistics: introduction, nature, concepts, evolution, importance, components and functions of logistics management; Introduction to supply chain management, value chain, supply chain effectiveness and Indian infrastructure, outsourcing and 3PLs and fourth party logistics(4PLs)

Unit 2: Elements of logistics and supply chain management: demand forecasting, functions of inventory, warehousing and distribution centres, transportation, protective packaging, order processing, material handling with special reference to agri products

Unit 3: Performance measurement of logistics and supply chain management (L &SCM) - dimensions, basic tools, impediments to improved performance; Logistic and supply chain management in Indian agri industry like edible oil industry, sugar industry, bakery and confectionary industry, cereal and pulses industry

Unit 4 : Issues in marketing and customer service with special reference to agri business: changing environment and the importance of Warehousing, Gap analysis for customer service management, efficient customer response planning for uncertainty, product costing for uncertainty

Unit 5: Logistics & supply chain management and Information technology in agri business-- from vertical integration to virtual integration, transiting from made- to- stock to build- to- order, integrated IT solutions for L&SCM, emerging technologies in L&SCM

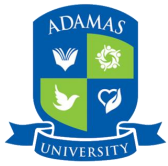
Suggested reading

Onur Boyabatli, Burak Kazaz, Christopher S. Tang .2022. Agricultural Supply Chain Management Research: Operations and Analytics in Planting, Selling, and Government Interventions.Springer

John Williams.2014. Agricultural Supply Chains and the Challenge of Price Risk. Routledge

N. Chandrasekaran, G. Raghuram.2014. Agribusiness Supply Chain Management. CRC Press

Organization for Economic Cooperation & Development.2016. OECD-FAO Guidance for Responsible Agricultural Supply Chains.FAO



John Williams.2013. Agricultural Supply Chains and the Challenge of Price Risk.
Routledge

Gopal Naik, G. Raghuram, Jothsna Rajan, Manu Bansal, Gopi S. Gopikuttan,
Prateek Tawri and Ritwik Singh.2022. Agricultural Warehousing in India: Trends,
Constraints, and Policies. Indian Institute of Management,