

# **PROPOSAL**

**for**

## **SEMESTER System Curriculum for M.Sc. (Ag.)**

**As Per:  
IV<sup>th</sup> DEANS' Committee  
ICAR, New Delhi**



## Syllabus for M.Sc. (Ag.) Agronomy

**AGRON 501                      MODERN CONCEPTS IN CROP PRODUCTION                      3(3+0)**

**Objective:** To teach the basic concepts of soil management and crop production.

### **Theory**

- UNIT I: Crop growth analysis in relation to environment; agro-ecological zones of India.
- UNIT II: Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.
- UNIT III: Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modelling for desired crop yield.
- UNIT IV: Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.
- UNIT V: Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

**AGRON 502                      PRINCIPLES AND PRACTICES OF WEED MANAGEMENT                      3(2+1)**

**Objective:** To familiarize the students about the weeds, herbicides and methods of weed control.

### **Theory**

- UNIT I: Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.
- UNIT II: Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.
- UNIT III: Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.
- UNIT IV: Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.
- UNIT V: Integrated weed management; cost: benefit analysis of weed management.

**Practical:** Identification of important weeds of different crops, Preparation of a weed herbarium, Weed survey in crops and cropping systems, Crop-weed competition studies; Preparation of spray solutions of herbicides for high and low-volume sprayers, Use of various types of spray pumps and nozzles and calculation of swath width; Economics of weed control; Herbicide resistance analysis in plant and soil; Bioassay of herbicide resistance; Calculation of herbicidal requirement.

### **AGRON 503 AGROMETEOROLOGY AND CROP WEATHER FORECASTING 3(2+1)**

**Objective:** To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

#### **Theory**

UNIT I: Agro meteorology: aim, scope and development in relation to crop environment, composition of atmosphere, distribution of atmospheric pressure,

UNIT II: Solar radiation: characteristics, radiation distribution in plant canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by crops,

UNIT III: Environmental temperature: soil, air, canopy temperature, temperature profile in air, soil and crop canopies, soil and air temperature effects on plant processes, regulation of air, soil temperature for protection against frost and hot winds, Environmental moisture and evaporation, measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship, evapotranspiration and meteorological factors determining evapotranspiration,

UNIT IV: Monsoon: monsoon and their origin, characteristics of monsoon, onset and progress of monsoon, withdrawal of monsoon,

UNIT V: Weather forecasting in India: short, medium and long range forecasting, benefits of weather service to agriculture, Remote sensing : application in agriculture, present status of remote sensing in India, Atmospheric pollution and its effect on climate and crop production.

**Practical:** Agrometeorological observatory- classes, site selection, layout and installation of meteorological instruments; handling of meteorological instruments; measurement of weather parameters; working out agroclimatic indices; maintenances of record; calculation of daily, weekly and monthly means; visit to state remote sensing centre, Jodhpur/Jaipur; measurement of soil temperature in different soil conditions/depths; interpretation and use of weather data; rainfall analysis for variability; moisture availability indices for an arid and a humid district, length of growing season, fitting cropping systems; preparation of weather maps, synoptic charts and weather reports; preparation of crop weather calendars, to become familiar with agro advisory service bulletins visit to ARS, Durgapura/Bikaner.

## **AGRON 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 3(2+1)**

**Objective:** To teach the principles of water management and practices to enhance the water productivity.

### **Theory**

UNIT I: Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II: Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III: Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and poly- houses.

UNIT IV: Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT V: Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

**Practical:** Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus, Soil-moisture characteristics curves, Water flow measurements using different devices, Determination of irrigation requirements, Calculation of irrigation efficiency, Determination of infiltration rate, Determination of saturated/unsaturated hydraulic conductivity

## **AGRON 505 SOIL FERTILITY AND NUTRIENT MANAGEMENT 3(2+1)**

**Objective:** To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

### **Theory**

UNIT I: Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

UNIT II: Criteria of essentiality of nutrients; Essential plant nutrients - their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III: Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT IV: Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions.

UNIT V: Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermin-compost and residue wastes in crops.

**Practical:** Determination of soil pH, E<sub>Ce</sub>, organic C, total N, available N, P, K and S in soils. Determination of total N, P, K and S in plants, Interpretation of interaction effects and computation of economic and yield optima.

### **AGRON 506      CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE      3(3+0)**

**Objective:** To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

#### **Theory**

UNIT I: Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT II: Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III: Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT IV: Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT V: Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

### **AGRON 507      AGRONOMY OF MAJOR CEREALS AND PULSES      3(2+1)**

**Objective:** To teach the crop husbandry of cereals and pulse crops.

**Theory:** Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of :

UNIT I: Rabi cereals.

UNIT II: Kharif cereals.

UNIT III: Rabi pulses.

UNIT IV: Kharif pulses.

**Practical:** Phenological studies at different growth stages of crop, Estimation of crop yield on the basis of yield attributes, Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities, Working out growth indices (CER, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops, Estimation of protein content in pulses, Planning and layout of field experiments, Judging of physiological maturity in different crops, Intercultural operations in different crops, Determination of cost of cultivation of different crops, Working out harvest index of various crops, Study of seed production techniques in various crops, Visit of field experiments on cultural, fertilizer, weed control and water management aspects, Visit to nearby villages for identification of constraints in crop production.

#### **AGRON 508 AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS**

**3(2+1)**

**Objective:** To teach the crop husbandry of oilseed, fiber and sugar crops.

**Theory:** Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of:

UNIT I: Rabi oilseeds - Rapeseed and mustard, linseed, etc.

UNIT II: Kharif oilseeds - Groundnut, sesame, castor, sunflower, soybean etc.

UNIT III: Fiber crops - Cotton, jute, sunhemp etc.

UNIT IV: Sugar crops - Sugar-beet and sugarcane.

**Practical:** Planning and layout of field experiments, Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane, Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice phenological studies at different growth stages of crop, Intercultural operations in different crops, Cotton seed treatment, Working out growth indices (LER, CGR, RGR, NAR, LAD) aggressivity, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems, Judging of physiological maturity in different crops and working out harvest index, Working out cost of cultivation of different crops, Estimation of crop yield on the basis of yield attributes, Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities, Determination of oil content in oilseeds and computation of oil yield, Estimation of quality of fibre of different fibre crops, Study of seed production techniques in various

crops, Visit of field experiments on cultural, fertilizer, weed control and water management aspects, Visit to nearby villages for identification of constraints in crop production.

**AGRON 509 PRINCIPLES AND PRACTICES OF ORGANIC FARMING 3(2+1)**

**Objective:** To study the principles and practices of organic farming for sustainable crop production.

**Theory**

UNIT I: Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II: Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures, biofertilizers, biodynamic and integrated bio nutrient management.

UNIT III: Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

**Practical:** Aerobic and anaerobic methods of making compost, Making of vermicompost and vermish, Identification and nursery raising of important agro-forestry trees and trees for shelter belts, Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field, Visit to an organic farm.

**AGRON 510 AGRONOMY OF FODDER AND FORAGE CROPS 3(2+1)**

**Objective:** To teach the crop husbandry of different forage and fodder crops along with their processing.

**Theory**

UNIT I: Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, bajra, guar, cowpea, oats, barley, berseem, senji, lucerne etc.

UNIT II: Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti quality factors of important forage crops/grasses- lime, napier grass, Panicum, Lasiurus, Cenchrus etc.

UNIT III: Year-round fodder production and management, preservation and utilization of forage and pasture crops.

UNIT IV: Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor quality fodder.

UNIT V: Economics of forage cultivation uses and seed production techniques.

**Practical:** Practical raining of farm operations in raising fodder crops; Canopy measurement, yield and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder and forage crops, Anti-quality components like HCN in sorghum and such factors in other crops, Hay and silage making and economics of their preparation.

### **AGRON 511 DRYLAND FARMING AND WATERSHED MANAGEMENT 3(3+0)**

**Objective:** To teach the basic concepts and practices of dry land farming and soil moisture conservation.

#### **Theory**

UNIT I: Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

UNIT II: Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III: Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

UNIT IV: Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V: Concept of watershed resource management, problems, approach and components.

**Practical:** Seed treatment, seed germination and crop establishment in relation to soil moisture contents, Moisture stress effects and recovery behaviour of important crops, Estimation of moisture index and aridity index, Spray of anti-transpirants and their effect on crops, Collection and interpretation of data for water balance equations • Water use efficiency, Preparation of crop plans for different drought conditions, Study of field experiments relevant to dryland farming, Visit to dryland research stations and watershed projects.

**Course Title** : Experimental Statistics  
**Course No.** : AES 513  
**Credit Hours** : 3 (2+1)  
**Semester** : I

**Objective:** This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

#### **Theory**

**UNIT I:** Introduction to statistics and its applications in agriculture, classification, tabulation and graphical representation of data.

**UNIT II:** Arithmetic mean, median, mode, standard deviation and coefficient of variation, moments, measures of Skewness & Kurtosis.

**UNIT III:** Concept of sampling, different sampling methods, sampling versus complete enumeration, simple random sampling with and without replacement, Use of random number tables for selection of simple random sample, stratified random sampling.

**UNIT VI:** Test of significance, Z-test and t-test for Means (One sample & two samples), F-test, Chi-square test of independence of attributes in  $2 \times 2$  contingency table.

**UNIT V:** Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**UNIT VI:** Experimental designs, need for designing of experiments, characteristics of a good design. Basic principles of designs, randomization, replication and local control, uniformity trials, size and shape of plots and blocks; Analysis of variance, Completely randomized design, randomized block design and Latin square design, Split plot and strip plot designs; missing plot technique in randomized block and Latin square design, factorial experiments (without confounding) in  $2^3$  designs.

#### **Practical**

- Application of Z-test.
- Application of t-test.
- Application of F-test.
- Chi-Square test of Goodness of Fit.
- Chi-Square test of Independence of Attributes for  $2 \times 2$  contingency table.
- Analysis of Variance One Way Classification.
- Analysis of Variance Two Way Classification.
- Selection of random sample using Simple Random Sampling.
- Correlation & Regression Analysis.
- Analysis of CRD, RBD and LSD

## **AGRON-599 Research Methodology (Special Paper)**

### **UNIT I: Research Methodology at a glance**

Importance and scope of research in agronomy for agricultural development. Objective of research, Requirement of research, Research planning, Characteristics of a research planning programme, Research problem, Steps for identifying a research problem.

### **UNIT II: Field Plot Techniques**

Principles of experimental design, Important design for field experimentation- Completely randomized design, Randomized block design and Latin square design, Planning and analysis of factorial experiments, Split plot design, confounding- complete and partial. Layout of the field, Deciding plot size,

### **UNIT III: Recording of data or Observation**

Rainfall, sunshine, relative humidity, soil temperature, Soil analysis: Texture, bulk density, pH, organic carbon; Biometric observation – Germination & Survival percent, Growth parameters, Yield and Yield attributing Traits and Qualitative traits.

### **UNIT IV: Agronomical Research Trials**

Study of different agronomical research trials conducted by government and private institutions. Prepare a report on agronomical research trials with its Introduction, Objective, Review of Literature and their citation, Technical programme, observation to be recorded and Possible outcomes.

### **UNIT V: Data Presentation and Writing Skills**

Diagrammatic presentation and its types, Collection of review of literature, Writing of bibliography, Preparation of synopsis. Writing of Abstract, Research paper, Popular articles, Presentation of research paper.



**Course Title : MICRO ECONOMIC THEORY AND APPLICATIONS**  
**Course No. : AES 501**  
**Credit Hours : 3(3+0)**  
**Semester : I**

**Objective:** This course is intended to provide an overview of microeconomic theory and its applications. The course starts with the theory of consumer behaviour consisting of consumer's utility maximization problem and demand theory. It intends to provide fundamental concepts and models in the theory of production and costs and sets out to provide a basic understanding of price and / or output determination under different types of market structures including factor markets. This course will also expose the students to the theory of general equilibrium and welfare economics.

### **Theory**

**UNIT I:** Theory of consumer behaviour, cardinal utility approach, ordinal utility approach, income effect and substitution effect, applications of indifference curve approach, revealed preference hypothesis, consumer surplus, derivation of demand curve, elasticity of demand.

**UNIT II:** Theory of production, production functions, returns to scale and economies of scale, technical progress, theory of costs, cost curves, profit maximization and cost minimization, derivation of supply curve, law of supply, producers' surplus.

**UNIT III:** Market equilibrium, behavior of firms in competitive markets, perfect competition, effect of taxation and subsidies on market equilibrium, monopoly, monopolistic, oligopoly, theory of factor markets.

**UNIT IV:** General equilibrium theory, welfare economics, pareto optimality, social welfare criteria, social welfare functions.

**Course Title : MACRO ECONOMIC THEORY AND APPLICATIONS**  
**Course No. : AES 502**  
**Credit Hours : 3 (3+0)**  
**Semester : II**

**Objective:** Macro economics and Policy course is intended to expose the students to macroeconomic concepts and theory, the application of the macro economic theory, and implication of the macroeconomic policies.

### **Theory**

**UNIT I:** Nature and scope of macro economics, methodology and Keynesian concepts national income, concepts and measurement, classical theory of employment and Say's law, modern theory of employment and effective demand.

**UNIT II:** Consumption function, investment and savings, concept of multiplier and accelerator, output and employment, rate of interest, classical, neo classical and Keynesian version, classical theory Vs Keynesian theory, unemployment and full employment.

**UNIT III:** Money and classical theories of money and price, Keynesian theory of money and Friedman restatement theory of money, supply of money, demand for money, inflation, its nature, effects and control.

**UNIT IV:** IS & LM frame work, general equilibrium of product and money markets, monetary policy, fiscal policy, effectiveness of monetary and fiscal policy, central banking.

**UNIT V:** Business cycles, balance of payment, foreign exchange rate determination.

**Course Title : EVOLUTION OF ECONOMIC THOUGHT**  
**Course No. : AES 503**  
**Credit Hours : 2 (2+0)**  
**Semester : III**

**Objective:** To introduce the students to the evolution of economic thought over a period of time, the background of emanation of thoughts and approaches, as acts of balancing and counter balancing events and criticisms. The course will also in a comprehensive way help the students to know and appreciate the contributions of the Galaxy of Economists.

### **Theory**

**UNIT 1:** Approaches for the study of history of economic thought, absolutist vs. relativist approaches, and evolution of economic Thought vs. Economic History, ancient economic thought, medieval economic thought, mercantilism, physiocracy, forerunners of classical political economy.

**UNIT II:** Development of classical thoughts (Adam Smith, Robert Malthus and David Ricardo) critics of classical thoughts, socialist critics, socialist and Marxian economic ideas, Austrian school of thought , origins of formal microeconomic analysis, William Stanley Jevons, Cournot and Dupuit.

**UNIT III:** The birth of neoclassical economic thought, Marshall and Walras, General equilibrium theory, welfare Theory, Keynesian economics.

**UNIT IV:** The era of globalization, experiences of developing world, rigidity of the past vs. emerging realism the changing path of international Institutions to economic growth and development approaches.

**UNIT V:** Economic thought in India, Naoroji and Gokhale, Gandhian economics, economic thought of independent, India Nehru's economic philosophy, experiences of the structural adjustment programmes of the post liberalization era.

**Course Title** : **AGRICULTURAL PRODUCTION ECONOMICS**  
**Course No.** : **AES 504**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **I**

**Objective:** To expose the students to the concept, significance and uses of agricultural production economics.

### **Theory**

**UNIT I:** Nature, scope and significance of agricultural production economics, agricultural production processes, character, and dimensions-spatial, temporal, centrality of production functions, assumptions of production functions, commonly used forms, properties, limitations, specification, estimation and interpretation of commonly used production functions.

**UNIT II:** Factors of production, classification, interdependence, and factor substitution, determination of optimal levels of production and factor application, optimal factor combination and least cost combination of production, theory of product choice; selection of optimal product combination.

**UNIT III** Production concept, resource product relationship in agriculture, important historical background and characteristics of different forms of production functions of linear, Quadratic, square root, Spillman, cubic, semi-log, cob- Douglas optimization, CES, VES and Leontief.

**UNIT VI:** Cost functions and cost curves, components, and cost minimization, duality theory, cost and production functions and its applications, derivation of firm's input demand and output supply functions, economies and diseconomies of scale.

**UNIT V:** Technology in agricultural production, nature and effects and measurement, measuring efficiency in agricultural production; technical, allocative and economic efficiencies, yield gap analysis, concepts-types and measurement, nature and sources of risk, modeling and coping strategies.

### **Practical**

- Different forms of production functions and its specification.
- Estimation and interpretation of production functions.
- Returns to scale, factor shares, elasticity of production, physical optima and economic optima.
- Least cost combination.
- Optimal product choice.
- Cost function estimation and interpretation.
- Estimation of yield gap.
- Incorporation of technology in production functions.
- Measuring returns to scale.
- Risk analysis through linear programming.

**Course Title : AGRICULTURAL MARKETING AND PRICE ANALYSIS**

**Course No. : AES 505**

**Credit Hours : 3 (2+1)**

**Semester : II**

**Objective:** To impart knowledge and analytical skills in the field of agricultural marketing and enhance expertise in improving the performance of the marketing institutions and its players.

### **Theory**

**UNIT I:** Review of concepts in agricultural marketing, characteristic of agricultural product and production problems in agricultural marketing from demand and supply and institutions sides. Market intermediaries and their role, need for regulation in the present context, marketable & marketed surplus estimation, marketing efficiency, structure conduct and performance analysis, vertical and horizontal integration, integration over space, time and form, vertical coordination.

**UNIT II:** Marketing co-operatives, APMC regulated markets, direct marketing, contract farming and retailing, supply chain management, state trading, warehousing and other government agencies, performance and strategies, market infrastructure needs, performance and Government role, value chain finance.

**UNIT III:** Role of information technology and telecommunication in marketing of agricultural commodities, market research, market information service, electronic auctions (e-bay), e-chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC), Market extension.

**UNIT IV :** Spatial and temporal price relationship, price forecasting, time series analysis, time series models, spectral, analysis, price policy and economic development, non-price instruments.

**UNIT V:** Theory of storage, introduction to commodities markets and future trading, basics of commodity futures, operation, mechanism of commodity markets, price discovery, hedging and basis, fundamental analysis, technical analysis, role of Government in promoting commodity trading and regulatory measures.

### **Practical**

- Supply and demand elasticity in relation to problems in agricultural marketing.
- Price spread and marketing efficiency analysis.
- Marketing structure analysis through concentration ratios.
- Performance analysis of regulated market and marketing societies.
- Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products.
- Chain Analysis quantitative estimation of supply chain efficiency.
- Market Intelligence, Characters, Accessibility, and Availability
- Price forecasting.
- Online searches for market information sources and interpretation of market intelligence reports, commodity outlook.
- Technical Analysis for important agricultural commodities
- Fundamental Analysis for important agricultural commodities
- Presentation of the survey results and wrap-up discussion.

**Course Title : RESEARCH METHODOLOGY**  
**Course No. : AES 506**  
**Credit Hours : 3 (2+1)**  
**Semester : I**

**Objective:** To expose the students to research methodology used in social sciences. The focus will be on providing knowledge related to research process, data collection and data analysis etc.

### **Theory**

**UNIT I:** Importance and scope of research in agricultural economics, types of research, fundamental vs. applied, concept of researchable problem, research prioritization, selection of research problem, approach to research, research process.

**UNIT II:** Hypothesis, meaning, characteristics, types of hypothesis, review of literature, setting of hypotheses, testing of hypothesis.

**UNIT III:** Sampling theory and sampling design, sampling error, methods of sampling, probability and non-probability sampling methods, criteria to choose, project proposals, contents and scope different types of projects to meet different needs, trade-off between scope and cost of the study, research design and techniques, types of research design.

**UNIT IV:** Data collection, assessment of data needs, sources of data collection, discussion of different situations, mailed questionnaire and interview schedule, structured, unstructured, open ended and closed-ended questions, scaling techniques, preparation of schedule, problems in measurement of variables in agriculture, interviewing techniques and field problems, methods of conducting survey, reconnaissance survey and pre testing.

**UNIT V:** Coding editing, tabulation, validation of data, tools of analysis, data processing, interpretation of results, preparing research report / thesis, Universal procedures for preparation of bibliography - writing of research articles.

### **Practical**

- Exercises in problem identification.
- Project proposals- contents and scope.
- Formulation of objective and hypotheses.
- Assessment of data needs and sources of data
- Methods of collection of data.
- Methods of sampling, criteria to choose and discussion on sampling under different situations. Scaling techniques and measurement of scales.
- Preparation of interview schedule and field testing.
- Method of conducting survey.
- Exercise on coding, editing, tabulation and validation of data.
- Preparing for data entry into computer.
- Hypothesis testing-Parametric and Non-Parametric tests.
- Exercises on format for thesis / report writing and presentation of the results

**Course Title** : **ECONOMETRICS**  
**Course No.** : **AES 507**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **III**

**Objective:** The Course Objective of the course is to impart knowledge on econometric tools to the students of agricultural economics. Training in econometrics will help the student to analyze the economic problem by applying quantitative techniques.

### **Theory**

**UNIT I:** Relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis.

**UNIT II :** Basic two variable regression, assumptions estimation and interpretation, approaches to estimation, OLS, MLE and their properties, extensions to multi variable models, multiple regression estimation and interpretation.

**UNIT III:** Violation of assumptions, identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation, data problems and remedial approaches, model misspecification.

**UNIT IV:** Use of dummy variables, limited dependent variables, specification, estimation and interpretation.

**UNIT V:** Simultaneous equation models, structural equations, reduced form equations, identification and approaches to estimation.

### **Practical**

- Single equation two variable model specification and estimation
- Hypothesis testing- transformations of functional forms
- OLS application-estimation of multiple regression model
- Hypothesis testing - testing and correcting specification errors
- Testing and managing multicollinearity
- Testing and managing heteroscedasticity
- Testing and managing autocorrelation
- Estimation of regressions with dummy variables
- Estimation of regression with limited dependent variable
- Identification of equations in simultaneous equation systems.

**Course Title** : **Linear Programming Methods**  
**Course No.** : **AES 508**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **III**

### **Theory**

**UNIT I:** Decision Making, concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems.

**UNIT II:** Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems, formulation of farms and non-farm problems as linear programming models and solutions.

**UNIT III:** Extension of linear programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

**UNIT IV:** Game Theory-Concepts of game theory, two person constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game as Linear Programme.

### **Practical**

- Formulation of linear programming problem-case studies.
- Graphical solution of linear programming problems.
- Algebraic solution of linear programming problems.
- Solving of maximization and minimization problems by simplex method.
- Formulation of the simplex matrices for typical farm situations.
- Primal and dual formulation of linear programming problems.
- Variable price and resource programming and other extensions of linear programming

**Course Title** : **AGRICULTURAL FINANCE AND PROJECT MANAGEMENT**  
**Course No.** : **AES 509**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **II**

**Objective:** The Course Objective of the course is to impart knowledge on issues related to lending to priority sector credit management and financial risk management. The course would bring in the various appraisal techniques in project - investment of agricultural projects.

### **Theory**

**UNIT I:** Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector Agricultural lending, direct and indirect financing, financing through Co-operatives, NABARD and commercial banks and RRBs, district credit plan and lending to agriculture/priority sector, micro-financing and role of MFI's - NGO's, and SHG's.

**UNIT II:** Lending to farmers, the concept of 3 C's, 7 P's and 3 R's of credit, estimation of technical feasibility, economic viability and repaying capacity of borrowers and appraisal of

credit proposals, understanding lenders and developing better working relationship and supervisory credit system, credit inclusions-credit widening and credit deepening.

**UNIT III:** Financial decisions, investment, financing, liquidity and solvency, preparation of financial statements-Balance Sheet, Cash Flow Statement and Profit and Loss Account, ratio analysis and assessing the performance of farm/ firm.

**UNIT IV:** Project approach in financing agriculture, financial, economic and environmental appraisal of investment projects, identification, preparation, appraisal, financing and implementation of projects, project appraisal techniques, undiscounted measures, time value of money, use of discounted measures, B-C ratio, NPV and IRR, agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects, Net work techniques - PERT and CPM.

**UNIT V:** Risks in financing agriculture, risk management strategies and coping mechanism, crop insurance programmes, review of different crop insurance schemes, yield loss and weather based insurance and their applications.

### **Practical**

- Development of Rural Institutional Lending, Branch expansion,
- Demand and supply of institutional agricultural credit
- Overview of rural lending programmes of Commercial Banks, Lead Bank Scheme.
- Preparation of District Credit Plan,
- Rural lending programmes of Co-operative lending Institutions,
- Preparation of financial statements using farm/firm level data,
- Farm credit appraisal techniques and farm financial analysis through financial statements,
- Performance of micro financing institutions -NGO's and Self-Help Groups,
- Identification and formulation of investment projects,
- Project appraisal techniques, undiscounted measures and their limitations.
- Project appraisal techniques, discounted measures,
- Network techniques-PERT and CPM for project management,
- Case study analysis of an agricultural project,
- Financial risk and risk management strategies-crop insurance schemes,
- Financial instruments and methods-e-banking, Kisan Cards and core banking.

**Course Title** : **RURAL MARKETING**  
**Course No.** : **AES 510**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **III**

**Objective:** To provide understanding regarding issues in rural markets like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

### **Theory**

**UNIT I:** Concept and scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India.

**UNIT II:** Environmental factors, socio-cultural, economic and other environmental factors affecting rural marketing.

**UNIT III:** Rural consumer's behavior, behavior of rural consumers and farmers; buyer characteristics and buying behavior; Rural v/s urban markets.

**UNIT IV:** Rural marketing strategy, marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; product mix, pricing policy and pricing strategy.

**UNIT V:** Product promotion, media planning, planning of distribution channels, and organizing personal selling in rural market in India.

### **Practical**

- Survey of rural market both primary and secondary.
- Study of marketing of a minor and major commodity with respect to rural marketing channels.
- Costs, margin and market price spread, market performance and rural market efficiency.
- On line searches for rural market information sources and interpretation of market intelligence report , submission of a report on above all aspects.

**Course Title** : **AGRICULTURAL DEVELOPMENT AND POLICIES**  
**Course No.** : **AES 511**  
**Credit Hours** : **3 (3+0)**  
**Semester** : **II**

**Objectives:** Provide orientation to the students regarding the concepts and measures of economic development, provide orientation on theories of economic growth and relevance of theories in developing countries, make them to understand the agricultural policies and its effect on sustainable agricultural development and make them to understand the globalization and its impact on agricultural development.

### **Theory**

**UNIT I:** Development economics, scope and importance, economic development and economic growth, divergence in concept and approach, indicators and measurement of economic development, GNP as a measure of economic growth, new measures of welfare, new and PQLI, HDI, Green GNP, criteria for under development, obstacles to economic development, economic and non-economic factors of economic growth.

**UNIT II:** Economic development, meaning, stages of economic development, determinants of economic growth. Theories of economic growth, Ricardian growth model, Harrod-Domar model, The Neo classical model of growth, The Kaldor model, optimal economic growth, recent experiences of developing country economies in transition, role of state in economic development, Government measures to promote economic development, Introduction to development planning.

**UNIT III:** Role of agriculture in economic/rural development, theories of agricultural development, population and food supply, need for sound agricultural policies, resource policies, credit policies, input and product marketing policies, price policies.

**UNIT IV:** Development issues, poverty, inequality, unemployment and environmental degradation models of agricultural development, induced innovation mode policy options for sustainable agricultural development.

**UNIT V:** Globalization and the relevance of development policy analysis, the dilemma of free trade?- Free trade versus protectionism, arguments for protection, arguments against protection. Role of protection in developing countries, WTO-Agreement on Agriculture, contradictions of free trade, proponents and opponents policies in vulnerable sectors like agriculture, lessons for developing countries.

**Course Title** : **Statistical Methods**  
**Course No.** : **AES 512**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **I**

Objective: This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

**Theory**

**UNIT I:** Descriptive statistics, theory of probability, discrete and continuous probability distributions, Binomial, Poisson, Normal distribution.

**UNIT II:** Concept of variables, equations and solving of simultaneous equations, factorization, indices, differentiation, some common law of differentiation, differentiation of power and exponential functions, Matrix algebra and determinants, concept of vectors, matrix addition, subtraction, multiplications and inversion.

**UNIT III:** Concept of sampling, Different sampling methods, sampling versus complete enumeration, simple random sampling with and without replacement, Use of random number tables for selection of simple random sample, stratified random sampling.

**UNIT VI:** Test of significance, Z-test and t-test for Means (One sample & two samples), F-test, Chi-square test of independence of attributes in  $2 \times 2$  contingency table, theory of confidence intervals.

**UNIT V:** Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**UNIT VI:** Analysis of time series, trend equation, construction of index number and uses, interpolation and extrapolation.

**Practical**

- Numerical problem of Binomial, Poisson, Normal distribution.
- Application of One Sample t-test.
- Application of Two Sample Fisher's t-test.
- Chi-Square test of Goodness of Fit.
- Chi-Square test of Independence of Attributes for  $2 \times 2$  contingency table.
- Analysis of Variance One Way Classification.
- Analysis of Variance Two Way Classification.
- Selection of random sample using Simple Random Sampling.
- Correlation & Regression Analysis.
- Construction of index.

**AES 599: Special Paper (Research Methods and Techniques in Agricultural Economics)**

**UNIT I:** Importance and scope of research in agricultural economics, types of research, fundamental vs. applied research, concept of researchable problem, research prioritization, selection of research problem, approach to research, research process, research design and techniques, types of research design, review of literature.

**UNIT II:** Sampling theory and sampling design, sampling error, methods of sampling, probability and non-probability sampling methods, hypothesis meaning, characteristics and its types, setting of hypotheses, testing of hypothesis.

**UNIT III:** Criteria to choose project proposals, contents and scope of different types of projects to meet different needs, trade-off between scope and cost of the study, identification, selection and formulation of agricultural project or case study of any agricultural enterprises unit, ex-post and ex-ante appraisal, and basic data requirement, discounted and undiscounted measures of project, SWOT analysis, preparation of scientific reports and presentation.

**UNIT IV:** Visit to regulated market to study various marketing functions performed by different marketing agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report.

**UNIT V:** Visit to NAFED or cooperative marketing society and analysis of its performance with the help of secondary data by using analytical tools and techniques.

# Name of Programme: M.Sc. (Ag.) Entomology

Academic eligibility for admission: - B.Sc. (Ag.)

## Curriculum and Syllabus

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
I <sup>st</sup> Sem.	ENT 501	Insect Morphology	2(1+1)	20	50	30	100
	ENT 502	Insect Anatomy, Physiology and Nutrition	3(2+1)	20	50	30	100
	ENT 504	Classification of Insects	3(2+1)	20	50	30	100
	ENT 505	Insect Ecology	2(1+1)	20	50	30	100
	AES 513	Experimental Statistics	3(2+1)	20	50	30	100
		Total		13			

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
II <sup>nd</sup> Sem.	ENT 507	Biological Control of Crop Pests and Weeds	2(1+1)	20	50	30	100
	ENT 508	Toxicology of Insecticides	3(2+1)	20	50	30	100
	ENT 509	Plant Resistance to Insects	2(1+1)	20	50	30	100
	ENT 510	Principles of Integrated Pest Management	2(1+2)	20	50	30	100
	ENT 511	Pests of Field Crops	2(1+1)	20	50	30	100
	ENT 513	Storage Entomology	2(1+1)	20	50	30	100
		Total		13			

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
III <sup>rd</sup> Sem.	ENT 512	Pests of Horticultural Crops	2(1+1)	20	50	30	100
	ENT 514	Vectors of Plant Diseases	2(1+1)	20	50	30	100
	ENT 515	General Acarology	2(1+1)	20	50	30	100
	ENT 517	Vertebrate Pest Management	2(1+1)	20	50	30	100
	ENT 518	Techniques in Plant Protection	1(0+1)	-	-	100	100
	ENT 519	Insects of Industrial Importance	2(1+1)	20	50	30	100
		Total		11			

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
IV <sup>th</sup> Sem.	ENT 591	Master's Seminar	1(0+1)	-	-	100	100
	ENT 599	Master's Research Or Entomological Research Methodology	20	-	-	-	S*
	Total		21				
	Grand Total		58				

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**ENTOMOLOGY**  
**Syllabus**

**ENT 501 INSECT MORPHOLOGY**

**2(1+1)**

**Objective:** To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.

**Theory**

UNIT I: Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

UNIT II: Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.

UNIT III: Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications.

UNIT IV: Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).

**Practical:** Study of insect segmentation, various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

**ENT 502 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION**

**3(2+1)**

**Objective:** To impart knowledge to the students on basic aspects of anatomy of different systems, elementary physiology, nutritional physiology and their application in entomology.

**Theory**

UNIT I: Scope and importance of insect anatomy and physiology.

UNIT II: Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, reproductive, endocrine and exocrine glands.

UNIT III: Thermodynamics; moulting; growth, metamorphosis and diapause.

UNIT IV: Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

**Practical:** Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic

analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

## ENT 504 CLASSIFICATION OF INSECTS

3(2+1)

**Objective:** To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

### Theory

UNIT I: Components of Biological Classification: Hierarchy, Rank, Category and Taxon. Species concepts, cryptic, sibling and etho- species, infra-specific categories. Nomenclature: Common vs Scientific names. International Code of Zoological Nomenclature, criteria for availability of names, validity of names. Categories of names under consideration of ICZN. Publications, Principles of priority, and homonymy, synonymy, type concept in zoological nomenclature. Speciation, anagenesis vs cladogenesis, allopatric, sympatric and parapatric processes

UNIT II: Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained.

UNIT III: Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

UNIT IV: Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

**Practical:** Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

## ENT 505 INSECT ECOLOGY

2(1+1)

**Objective:** To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, organization of communities, diversity indices. Train students in sampling methodology, calculation of diversity indices, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

### Theory

UNIT I: History and Definition. Basic Concepts. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis.

UNIT II: Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

UNIT III: Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions. Competition- Lotka-Volterra model, Concept of niche ecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration.

UNIT IV: Community ecology- Concept of guild, Organisation of communities. Pest management as applied ecology.

**Practical:** Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects. Measurement of Micro-environment, Constructions of Life table. Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

## ENT 507 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS

2(1+1)

**Objective:** To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

## **Theory**

UNIT I: History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.

UNIT II: Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.

UNIT III: Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.

UNIT IV: Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

**Practical:** Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

## **ENT 508 TOXICOLOGY OF INSECTICIDES**

**3(2+1)**

**Objective:** To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

## **Theory**

UNIT I: Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

UNIT II: 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 pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

UNIT III: 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 IV: Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

UNIT V: 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:** Insecticide formulations and mixtures; quality control of pesticide formulations; 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.

#### **ENT 509 PLANT RESISTANCE TO INSECTS**

**2(1+1)**

**Objective:** To familiarize the students with types, basis, mechanisms and genetics of resistance in plants to insects and role of plant resistance in pest management.

##### **Theory**

UNIT I: History and importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT II: Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III: Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

UNIT IV: Factors affecting plant resistance including biotypes and measures to combat them.

UNIT V: Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

UNIT VI: Role of biotechnology in plant resistance to insects.

**Practical:** Screening techniques for measuring resistance; measurement of plant characters and working out their correlations with plant resistance; testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis, tolerance and antixenosis.

#### **ENT 510 PRINCIPLES OF INTEGRATED PEST MANAGEMENT**

**2(1+1)**

**Objective:** To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

##### **Theory**

UNIT I: History and origin, definition and evolution of various related terminologies.

UNIT II: Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

UNIT III: Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

**Practical:** Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system.

### ENT 511 PESTS OF FIELD CROPS

2(1+1)

**Objective:** To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

**Theory:** Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.

UNIT I: Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).

UNIT II: Insect pests of pulses, tobacco, oilseeds and their management.

UNIT III: Insect pests of fibre crops, forages, sugarcane and their management.

**Practical:** Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

### ENT 512 PESTS OF HORTICULTURAL CROPS

2(1+1)

**Objective:** To impart knowledge on major pests of horticultural crops regarding the extent and nature of loss, seasonal history, their integrated management.

**Theory:** Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect pests of various crops.

UNIT I: Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits.

UNIT II: Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, french beans, chow-chow, brinjal, okra, all gourds, drumstick, leafy vegetables etc.

UNIT III: Plantation crop- coffee, tea, coconut. Spices and Condiments- pepper, cardamom,

clove, chillies, turmeric, ginger, beetlevine etc.

UNIT IV: Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation

**Practical:** Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non- insect pests.

### ENT 513 STORAGE ENTOMOLOGY

2(1+1)

**Objective:** To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage.

#### **Theory:**

UNIT I: Introduction, history of storage entomology. Post-harvest losses in toto visa-vis total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Important pests viz., insects, mites, rodents, birds and microorganisms (their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations) associated with stored grain and field conditions including agricultural products.

UNIT II: Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

UNIT III: Control of infestation by insect pests, mites, rodents, birds and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures, non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

**Practical:** Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of insect infestation in stored food grains; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSRI, Hapur etc. (only where logistically feasible).

## ENT 514 VECTORS OF PLANT DISEASES

2(1+1)

**Objective** To teach the students about the different groups of insects that vector plant pathogens, vector-plant pathogen interaction, management of vectors for controlling diseases

### Theory

UNIT I: History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

UNIT II: Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

UNIT III: Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

UNIT IV: Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

UNIT V: Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

**Practical:** Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies.

## ENT515 GENERAL ACAROLOGY

2(1+1)

**Objective:** To acquaint the students with external morphology of different groups of mites, train in identification of commonly occurring families of plant associated mites, provide information about important mite pests of crops and their management.

### Theory

**UNIT I:** History of Acarology; importance of mites as a group; habitat, collection and preservation of mites.

**UNIT II:** Introduction to morphology and biology of mites and ticks. Broad classification- major orders and important families of Acari including diagnostic characteristics.

**UNIT III:** Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees. Management of mites using acaricides, phytoseiid predators, fungal pathogens *etc.* Culturing of phytophagous, parasitic and predatory mites.

**Practical:** Collection of mites from plants, soil and animals; extraction of mites from soil, plants and stored products; preparation of mounting media and slide mounts; external morphology of mites; identification of mites up to family level using keys; studying different rearing techniques for mites.

**ENT 517 VERTEBRATE PEST MANAGEMENT****2(1+1)**

**Objective:** To impart knowledge on vertebrate pests like birds, rodents, mammals etc., of different crops, their biology, damage they cause and management strategies.

**Theory**

**UNIT I:** Vertebrate pests of different crops; biology of vertebrate pests such as rodents, birds and other mammals. Biology of beneficial birds.

**UNIT II:** Population dynamics and assessment, patterns of pest damage and assessment, roosting and nesting systems in birds.

**UNIT III:** Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods- Operational practices- baiting, bioassays (LD50 studies), equipments and educative programmes.

**Practical:** Identification of important rodent and other vertebrate pests of agriculture, food preference and hoarding, social behaviour, damage assessment, field survey, population estimation, control operation and preventive methods.

**ENT 518 TECHNIQUES IN PLANT PROTECTION****1(0+1)**

**Objective:** To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopy, computation, pest forecasting, electrophoresis etc.

**Theory**

**UNIT I:** Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, seed dressing, soaking, root-dip treatment, dusting, spraying, application through irrigation water.

**UNIT II:** Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers.

**UNIT III:** Use of light, transmission and scanning electron microscopy.

**UNIT IV:** Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.

**UNIT V:** Use of tissue culture techniques in plant protection. Computer application for predicting/forecasting pest attack and identification.

## ENT 519 INSECTS OF INDUSTRIAL IMPORTANCE

2(1+1)

**Objective:** To familiarize the students with entrepreneurial opportunities in entomology, provide information on productive insects and their products.

**Theory:**

UNIT I: Bee keeping- General colony management during different seasons. Managing colonies for bee-hive products and pollination. Artificial queen rearing. Pests and diseases of honey bees. Bee poisoning. Production and marketing of quality honey and value added honey products. Establishment and maintenance of apiaries.

UNIT II: Study of different species of silkworms, characteristic features, moriculture, arboriculture, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms.

UNIT III: Lac insect- Introduction, method of rearing, pests of lac and their management.

**Practical:** Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-keeping equipments. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Preparation of bee-keeping projects for funding. Visit to bee nursery and commercial apiaries. Silkworm rearing and management. Lac host and crop management technology and processing of lac. Products and bye-products of lac.

**Course Title** : Experimental Statistics  
**Course No.** : AES 513  
**Credit Hours** : 3 (2+1)  
**Semester** : I

**Objective:** This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

### **Theory**

**UNIT I:** Introduction to statistics and its applications in agriculture, classification, tabulation and graphical representation of data.

**UNIT II:** Arithmetic mean, median, mode, standard deviation and coefficient of variation, moments, measures of Skewness & Kurtosis.

**UNIT III:** Concept of sampling, different sampling methods, sampling versus complete enumeration, simple random sampling with and without replacement, Use of random number tables for selection of simple random sample, stratified random sampling.

**UNIT VI:** Test of significance, Z-test and t-test for Means (One sample & two samples), F-test, Chi-square test of independence of attributes in  $2 \times 2$  contingency table.

**UNIT V:** Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**UNIT VI:** Experimental designs, need for designing of experiments, characteristics of a good design. Basic principles of designs, randomization, replication and local control, uniformity trials, size and shape of plots and blocks; Analysis of variance, Completely randomized design, randomized block design and Latin square design, Split plot and strip plot designs; missing plot technique in randomized block and Latin square design, factorial experiments (without confounding) in  $2^3$  designs.

### **Practical**

- Application of Z-test.
- Application of t-test.
- Application of F-test.
- Chi-Square test of Goodness of Fit.
- Chi-Square test of Independence of Attributes for  $2 \times 2$  contingency table.
- Analysis of Variance One Way Classification.
- Analysis of Variance Two Way Classification.
- Selection of random sample using Simple Random Sampling.
- Correlation & Regression Analysis.
- Analysis of CRD, RBD and LSD

## **ENT-599 Entomological Research Methodology (Special Paper)**

### **UNIT I: Research Methodology at a glance**

Importance and scope of research in agricultural entomology in relation to development of agriculture, Fundamental and applied problems in entomology and their implications, steps involved in any research project, recording, transformation, tabulation, diagrammatic presentation of data in various types of research problems, literature collection, preparation of synopsis and scientific papers.

### **UNIT II: Toxicological & Physiological Research Methodology**

Scope of toxicology in agriculture, Research designs in field, storage and laboratory for estimation of toxicity of insecticides and other chemical agents used against insects, exercises on probit analysis, residue deposit per unit area, persistence, tolerance limits, half life values, PT index, LC 50, Ld 50, LT 50 values, methods of determination of insecticidal residues, Determination of resistance to insecticides.

Bio-chemistry and role of proteins, carbohydrates lipids, vitamins and amino acids in nutritional requirement using modern methods of analysis, preparation of synthetic diets of insects. Physiology of host selection in insects, Elementary knowledge of paper chromatography, TLC, GIC, and other modern analytical methods. Micro-techniques, Histology of different parts and organs. Determination of pH of different parts of alimentary canal.

### **UNIT III: Entomological Techniques**

Techniques involved in collection, killing, preservation, pinning, setting, labeling, handling, rearing and storing of insects, Insectory and insect cages, Determination of temperature and humidity and other entomological techniques, preparation of specimen for transferring them for identification.

### **UNIT IV: IPM Package of Field Crops**

Assessment of losses in fields and storages, computation and analysis of data. Economics of insect-pests control. Collection and identification of important crop pests and their natural enemies, field observations on damage caused by insect-pests, study of life history of insect-pests from cereal, fibre, oilseed, pulses and sugarcane crops.

### **UNIT V: IPM Package of Horticultural Crops**

Collection and identification of important fruit and vegetable crop pests and their natural enemies, field observations on damage caused by insect-pests, study of life history of insect-pests of vegetables like tomato, chilli, cabbage, cauliflower, brinjal, okra, all gourds and fruits like mango, guava, banana, papaya, citrus and other important fruits of this region.



## **M.Sc. (Ag.) Agricultural Extension Syllabus**

**EXT 511                      Development Perspectives of Extension Education                      3 (2+1)**

### **Objective**

The course is intended to orient the students with the concept of extension education and its importance in Agriculture development and also to expose the students with various Rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis. Besides, the students will be learning about the new innovations being brought into the Agricultural Extension in India.

### **Theory**

**UNIT I:** Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

**UNIT II:** Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.

**UNIT III:** Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

**UNIT IV:** Current Approaches in Extension: Decentralised Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

**Practical:** Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

**EXT 512                      Development Communication and Information Management                      3 (2+1)**

### **Objective**

In this course, students will learn about the concept, meaning and process of communication and various methods and modern media of communication. Besides, the students will also learn the information management and journalistic writing of various information materials and also study their readability.

## **Theory**

**UNIT I:** Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

**UNIT II:** Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.

**UNIT III:** Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.

**UNIT IV:** Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

**Practical:** Writing news for farm news paper/Magazines. Reporting of various Extension activities like-Field day, Training, result demonstration and farmers fair etc. preparing and delivering effective speech. Handling of communication and recording equipments (like- Computer, P.A. System & camera). Script writing for Radio, T.V. Conducting students visit to Radio & T.V. station.

**EXT 513**

**Diffusion and Adoption of Innovations**

**3 (2+1)**

## **Objective**

The students will learn how the agricultural innovations spread among the farmers in the society by getting into the insights of diffusion concept and adoption process, stages of adoption and innovation decision process, adopter categories and their characteristics, opinion leaders and their characteristics, attributes of innovations, and factors influencing adoption. In addition, the students would be learning various concepts related to diffusion and adoption of innovations.

## **Theory**

**UNIT I:** Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.

**UNIT II:** The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.

**UNIT III:** Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

**UNIT IV:** Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

**Practical:** Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

**EXT 521**

**E- Extension**

**3 (2+1)**

## **Objective**

Students will gain knowledge and skills in understanding the concepts of Information and communication technologies and how these ICT tools can be used for Agricultural Extension. Besides, he studies various ICT projects which are successful in delivering the services to the clientele fulfilling the objective of Transfer of Technology i.e. Reaching the unreached.

## **Theory**

**UNIT I:** ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities.

UNIT II: ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III: Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts.

UNIT IV: ICT Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. Basic e-extension training issues. ICT enabled extension pluralism. Emerging issues in ICT.

**Practical:** Agril.content analysis of ICT Projects. Handling of ICT tools. Designing extension content. Online extension service. Project work on ICT enabled extension. Creation of extension blogs. Visit to ICT extension projects.

## **EXT 522 Entrepreneurship Development and Management in Extension 3 (2+1)**

### **Objective**

The first part of the course is intended to provide overall picture of planning and development of enterprises for extending sustainable livelihoods for rural people. The second part of the course is structured to help the students to gain knowledge and skills in different concepts and techniques of management in extension organizations.

### **Theory**

UNIT I: Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.

UNIT II: Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a

development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing.

**UNIT III:** Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

**UNIT IV:** Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

**Practical:** Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions-Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management-Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

**EXT 523**

**Human Resource Development (HRD)**

**3 (2+1)**

### **Objective**

To orient the students about key concepts importance, scope & conceptual frame work, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organization and process of HRD.

## **Theory**

**UNIT I:** Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal.

**UNIT II:** Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process–communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Skills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics :Leadership styles – Group dynamics.

**UNIT III:** Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

**Practical:** Visit to different training organizations to review on going activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and Human resource information, Presentation of reports.

**EXT 524 Participatory Methods for Technology Development and Transfer 3 (2+1)**

## **Objective**

This course is intended to orient the students with the key concepts, principles process of different participatory approaches for technology development and transfer and also to

expose the students with various participatory tools and techniques like space related, time related, relation oriented methods. Besides the students will be learning the preparation of action plans participatory monitoring and evaluation.

### **Theory**

UNIT I: Participatory extension – Importance, key features, principles and process of participatory approaches; Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models.

UNIT II: Participatory tools and techniques. Space Related Methods : village map (social & resource), mobility services and opportunities map and transect; Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule, dream map; Relation oriented methods : cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis.

UNIT III: Preparation of action plans, concept and action plan preparation; Participatory technology development and dissemination; Participatory planning and management, phases and steps in planning and implementation aspects; Process monitoring, participatory evaluation.

**Practical:** Simulated exercises on space related methods, time related method and relation oriented methods; Documentation of PTD and dissemination; Preparation of action plan; Participatory monitoring and evaluation of developmental programmes.

**EXT 525**

**Agricultural Journalism**

**3 (2+1)**

### **Theory**

UNIT I: Agricultural Journalism: The nature and scope of agricultural journalism characteristics and training of the agricultural journalist, how agricultural journalism is similar to and different from other types of journalism.

UNIT II: Newspapers and magazines as communication media: Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers. UNIT III: Form and content of newspapers and magazines: Style and language of newspapers and magazines, parts of newspapers and magazines.

UNIT III: The agricultural story: Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story.

UNIT IV: Gathering agricultural information: Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources.

UNIT V: Writing the story: organizing the material, treatment of the story, writing the news lead and the body, readability measures.

UNIT VI: Illustrating agricultural stories: Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions. Editorial mechanics: Copy reading, headline and title writing, proofreading, lay outting.

**Practical:** Practice in interviewing. Covering agricultural events. Abstracting stories from research and scientific materials and from wire services. Writing different types of agricultural stories. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading, headline and title writing, proofreading, lay-outting. Testing copy with a readability formula. Visit to a publishing office.

**EXT 531                      Research Methods in Behavioural Science                      3 (2+1)**

### **Objective**

This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the Statistical Package for Social Sciences (SPSS) for choosing appropriate statistics for data analysis.

### **Theory**

UNIT I: Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, Planning the review work. Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.

UNIT II: Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors

affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximinon Principle, Sampling – Types of sampling and sampling procedures.

**UNIT III:** Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre – testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.

**UNIT IV:** Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences ( SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

**Practical:** Selection and formulation of research problem - Formulation of objectives and hypothesis-Selection of variables based on objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.-Testing the validity and reliability of the data collection instruments.- Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research.Writing report, Writing of thesis and research articles-Presentation of reports.

**EXT 532**

**Visual Communication**

**3 (2+1)**

### **Objective**

This course is intended to give a clear perspective about the importance of visuals and graphics in communication. The course starts with the delineating about the characteristics of visuals and graphics followed by its main functions, theories of visual perception and its classification and selection. Further, the course deals with the designing the message, graphic formats and devices and presentation of data. It makes the students to understand, prepare and



experience and cases. Research - Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership. Stakeholder's analysis in Extension. Main streaming gender in Extension - Issues and Prospects.

**UNIT III:** Implications of WTO - AOA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI-NGO collaboration to improve efficiency of extension.

**UNIT IV:** Extension and contemporary issues: Extension and issues related to rural poverty. Privatization of Extension. Intellectual Property Rights (IPRs). Extension Reforms in India - Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups. Organization innovations in Extension - ATIC, IVLP, Kisan Call Centres.

**Practical:** Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension. Analysis of ATMA and SREP. Practicing bottom up planning. Visit to Public-Private -Farmer partnership. Learnings from Food and Nutritional Security and bio-diversity Projects and Programmes.

**Course Title** : **Statistical Methods**  
**Course No.** : **AES 512**  
**Credit Hours** : **3 (2+1)**  
**Semester** : **I**

Objective: This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

### **Theory**

**UNIT I:** Descriptive statistics, theory of probability, discrete and continuous probability distributions, Binomial, Poisson, Normal distribution.

**UNIT II:** Concept of variables, equations and solving of simultaneous equations, factorization, indices, differentiation, some common law of differentiation, differentiation of power and exponential functions, Matrix algebra and determinants, concept of vectors, matrix addition, subtraction, multiplications and inversion.

**UNIT III:** Concept of sampling, Different sampling methods, sampling versus complete enumeration, simple random sampling with and without replacement, Use of random number tables for selection of simple random sample, stratified random sampling.

**UNIT VI:** Test of significance, Z-test and t-test for Means (One sample & two samples), F-test, Chi-square test of independence of attributes in  $2 \times 2$  contingency table, theory of confidence intervals.

**UNIT V:** Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**UNIT VI:** Analysis of time series, trend equation, construction of index number and uses, interpolation and extrapolation.

### **Practical**

- Numerical problem of Binomial, Poisson, Normal distribution.
- Application of One Sample t-test.
- Application of Two Sample Fisher's t-test.
- Chi-Square test of Goodness of Fit.
- Chi-Square test of Independence of Attributes for  $2 \times 2$  contingency table.
- Analysis of Variance One Way Classification.
- Analysis of Variance Two Way Classification.
- Selection of random sample using Simple Random Sampling.
- Correlation & Regression Analysis.
- Construction of index.

**Research Methodology in Agricultural Extension**

**Unit I – Research: Meaning, Importance, Characteristics.** Behavioural science research: Meaning, Concept and Problems in behavioural sciences research.

Types and methods of research: Fundamental, Applied and action research. Exploratory research, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case study.

Research problems: Selection and formulation of research problems and guiding principles in choice of research problems and development of theoretical orientation of the research problems.

**Unit II – Research design: Meaning, Need of research design and features of a good research design.**

Hypothesis: Meaning, Importance and function of hypothesis in research.

Data collection tools: Interview schedule - Meaning, Purpose, Types and techniques of interviewing limitation. Questionnaires – Meaning, Difference between Schedule and Questionnaire types of questions to be used in pre-testing the questionnaire and schedule.

Case study: Meaning, types, advantages and limitations in its use, observation.

Social survey: Meaning, objectives, types and steps in survey conducting advantages and limitation.

**Unit III – Measurement: Meaning, levels of measurement use of appropriate statistics at different level of measurement in research. Technique of developing measurement tools.**

Scaling technique: Meaning and type, steps in construction of scale. Advantages and limitation of its use. Selection of appropriate method of data collection.

Data processing: Meaning, coding, preparation of master sheets, Data processing etc.

**Unit IV – Introduction to library and its services. Role of libraries in education. Research and technology**

transfer. Classification and organization of library. Sources of information: Primary sources,

Secondary sources and tertiary sources. Intricacies of

abstracting and indexing services (Science, citation, Abstract, CABI, Abstract). Review of literature:

Need, Search and Procedure, Sources of literature, planning the review work. Tracing information

from reference sources, literature, survey, citation, techniques of preparation of bibliography,

C.D.- ROM, Data base, online public access catalogue and other computerized libraries services.

Use of internet And its resources.

**Unit V- Technical writing: Various forms of scientific writings – There technical papers, reviews manuals**

etc. Various parts of thesis and research communications (Title page, Authorship, Content page,

Preface, Introduction, Review of literature, Material and Methods, Experimental result and discussion).

Writing of Abstract, Summaries, precise, Citation etc. Commonly use abbreviation in thesis and

research. Communication illustrations. Photographs and drawing with suitable caption, pagination,

numbering of tables and illustration. Writing numbers and dates in scientific write-ups, editing and

proof reading, writing of reviews articles.

## M.Sc. (Ag.): GENETICS & PLANT BREEDING

Code No.	Course Title	Credit	Marks			Total
			Theory	Practical	Mid Term	
GPB-501	Principles of Genetics	3(2+1)	50	30	20	100
GPB-502	Principles of Cytogenetics	3(2+1)	50	30	20	100
GPB-503	Principles of Plant Breeding	3(2+1)	50	30	20	100
GPB-504	Principles of Population & Quantitative Genetics	3(2+1)	50	30	20	100
GPB-505	Breeding of Field Crops	3(2+1)	50	30	20	100
GPB-506	Advanced Seed Technology	3(2+1)	50	30	20	100
GPB-507	Breeding Designer Crops	3(2+1)	50	30	20	100
GPB-508	Heterosis Breeding	3(2+1)	50	30	20	100
GPB-509	Cell Biology & Molecular Genetics	3(2+1)	50	30	20	100
GPB-510	Biotechnology For Crop Improvement	3(2+1)	50	30	20	100
GPB-511	Maintenance Breeding, Variety Release & Seed Production	2(1+1)	50	30	20	100
AES-513	Experimental Statistics	3(2+1)	50	30	20	100
	<b>Total</b>	<b>35</b>				
<b>Semester-wise Course Distribution</b>						
<b>1st Semester</b>						
GPB-501	Principles of Genetics	3(2+1)	50	30	20	100
GPB-502	Principles of Cytogenetics	3(2+1)	50	30	20	100
GPB-503	Principles of Plant Breeding	3(2+1)	50	30	20	100
AES-513	Experimental Statistics	3(2+1)	50	30	20	100
	<b>Total</b>	<b>12</b>				
<b>2nd Semester</b>						
GPB-504	Principles of Population & Quantitative Genetics	3(2+1)	50	30	20	100
GPB-505	Breeding of Field Crops	3(2+1)	50	30	20	100
GPB-506	Advanced Seed Technology	3(2+1)	50	30	20	100
GPB-507	Breeding Designer Crops	3(2+1)	50	30	20	100
	<b>Total</b>	<b>12</b>				
<b>3rd Semester</b>						
GPB-508	Heterosis Breeding	3(2+1)	50	30	20	100
GPB-509	Cell Biology & Molecular Genetics	3(2+1)	50	30	20	100
GPB-510	Biotechnology For Crop Improvement	3(2+1)	50	30	20	100
GPB-511	Maintenance Breeding, Variety Release & Seed Production	2(1+1)	50	30	20	100
	<b>Total</b>	<b>11</b>				
<b>4th Semester</b>						
GPB-599	Master Seminar	1	-	-	-	100
GPB-599	Master Research Or Research Methodology	20	-	-	-	S*
	<b>Total</b>	<b>21</b>				
	<b>Grand Total</b>	<b>56</b>				

S\* = Satisfactory

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*T. K. Kishor*  
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# GENETICS AND PLANT BREEDING

## Course Content

GPB 501

PRINCIPLES OF GENETICS

3(2+1)

### Theory

#### UNIT I

Beginnings of genetics; cell structure and cell division; early concepts of inheritance; Mendel's laws; discussion on Mendel's paper; chromosomal theory of inheritance .

#### UNIT II

Multiple alleles; Gene interactions; sex determination coma differentiation and sex linkage; sex influenced and sex limited traits; linkage detection and estimation; recombination and genetic mapping in eukaryotes; somatic cell genetics; extra-chromosomal inheritance.

#### UNIT III

Structural and numerical changes in chromosomes; nature structure and replication of genetic material; organization of DNA in chromosomes; genetic code; protein biosynthesis.

#### UNIT IV

Genetic fine Structure Analysis; allelic complementation; split genes; transposable genetic elements; overlapping genes; Pseudogenes; oncogenes; gene families and clusters.

#### UNIT V

Regulation of gene activity in prokaryotes; molecular mechanism of mutation; repair and suppression; bacterial plasmids insertion (IS) and transposable Elements (Tn); Molecular chaperones and gene expression; gene regulation in eukaryotes; RNA editing.

#### UNIT VI

Gene isolation synthesis and cloning; genomic and cDNA libraries; PCR based cloning, positional cloning; DNA Sequencing; DNA restriction and modification; antisense RNA and ribozymes; micro RNAs (miRNAs).

#### UNIT VII

Genomics and proteomics; functional and pharmacogenomics; metagenomics.

#### UNIT VIII

Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; gene silencing; Genetics of Mitochondria and chloroplast.

#### UNIT IX

Concept of eugenics; epigenetics; genetic disorders and behavioral genetics.

### **Practical**

Laboratory exercises in probability and Chi square; demonstration of genetic principles using laboratory organisms; chromosome mapping using three point testcross; tetrad analysis; induction and detection of mutations through genetic tests; DNA extraction and PCR amplification. electrophoresis- basic principles and running of amplified DNA. extraction of proteins and enzymes; use of agrobacterium mediated method and biolistic gun; practical demonstrations- detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

GPB 502

## **PRINCIPLES OF CYTOGENETICS**

3(2 +1)

### **UNIT I**

Architecture of chromosomes in prokaryotes and eukaryotes; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; special types of chromosomes.

### **UNIT II**

Chromosomal theory of inheritance; cell cycle and cell division; mitosis and meiosis; differences, significance and deviations; synopsis, structure function of synaptonemal complex and spindle apparatus; anaphase movement of chromosomes and crossing over mechanism and theories of crossing over recombination models cytological basis, variation in chromosome structure; evolutionary significance; introduction to two techniques for karyotyping; chromosome banding and painting; in situ hybridization and various applications.

### **UNIT III**

Structural and numerical variations of chromosomes and their implications; symbols and terminologies for chromosome numbers; euploidy, haploids, diploid and polyploids. utilization of a nucleoid in gene location; variation in chromosome behaviour; somatic segregation and chimeras; Endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations- Balanced lethals and chromosome complexes.

### **UNIT IV**

Intervarietal chromosome substitutions; polyploidy and role of polyploidy in crop breeding; advantages of autopolyploids vs allopolyploids; Role of fluids in basic and applied aspect of Crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer alien addition and substitution lines; creation and utilization and exploitation of apomixis in crops.

### **UNIT V**

Interspecific hybridization and allopolyploids; Synthesis of new crops- wheat, tritcale and *Brassica*.

### **UNIT VI**

Fertilization barriers in crop plants at pre- and post-fertilization levels. *in-vitro* techniques to overcome the fertilization barriers in crops.

### **Practical**

Learning the Cytogenetics laboratory; various chemicals to be used for fixation, preservation & staining. Various types of microscopes, simple & compound microscope. Temporary slide preparation of mitosis in onion roots, temporary slide preparation of meiosis in onion flower buds. Estimation of pollen viability in various flower buds of crops. Anther culture, ovule culture and endosperm culture.

**Objectives**

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

**Theory****UNIT I**

History of plant breeding (Pre-and post-Mendelian era); Objectives of plant breeding; characteristics improved by plant breeding; Patterns of evolution in crop plants-Centres of origin-biodiversity and its significance.

**UNIT II**

Genetic basis of breeding self-and cross-pollinated crops including mating systems and response to selection-nature of variability, components of variation; Heritability and genetic advance, genotype-environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

**UNIT III**

Self-incompatibility and male sterility in crop plants and their commercial exploitation.

**UNIT III**

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

**UNIT IV**

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods;  $S_1$  and  $S_2$  progeny testing, progeny selection schemes, recurrent selection schemes for intra-and inter-population improvement and development of synthetics and composites; Hybrid breeding-genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

#### UNIT V

Breeding methods in asexually/clonally propagated crops, clonal selection, apomixes.

#### UNIT VI

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.

#### UNIT VII

Special breeding techniques-Mutation breeding; Breeding for abiotic and biotic stresses.

#### UNIT VIII

Cultivar development-testing, release and notification, maintenance breeding, Participatory plant breeding, Plant breeders' right and regulations for plant variety protection and farmers rights.

#### **Practical**

Floral biology in self and cross pollinated species, selfing and crossing techniques; Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

**Theory****UNIT I**

Population- properties of population, Mendelian population, Genetic constitution of a population through time, space, age structure etc. Mating systems- Random mating population, Frequencies of genes and genotypes, Causes of Change, population size, differences in fertility and viability, migration and mutation.

**UNIT II**

Hardy-Weinberg equilibrium, Hardy-Weinberg Law, Proof, Applications of the Hardy-Weinberg Law, test of Hardy-Weinberg equilibrium.

**UNIT III**

Multiple alleles, more than one locus, sex-linked genes. Use of gene- & genotypic frequencies and their estimation.

**UNIT IV**

Mendelian traits vs Polygenic traits, nature of quantitative traits and it's inheritance, Multiple factor hypothesis, Analysis of continuous variation. Nature of gene action: additive, dominance and epistatic.

**UNIT V**

Principles of analysis of variance (ANOVA). Design for plant breeding experiments, principles and applications. Genetic diversity analysis, metroglyph-, cluster- and  $D^2$  statistic. Analysis of phenotypic and genotypic correlations, path analysis, and parent-progeny regression analysis. Concept of selection, Heritability and genetic advance.

**UNIT VI**

Generation mean analysis, mating designs- diallel, partial diallel, Line x Tester analysis, NCDs, and TTC, Combining ability and gene action, analysis of G x E interaction, adaptability and stability; Models for G x E analysis and stability parameters.

**Practical**

Exercise on prove of Hardy-Weinberg equilibrium. Estimation of gene- and genotype frequencies. Factors affecting gene frequencies. Problems on multiple factor inheritance.

Estimation of Heritability and genetic advance. Preparation of ANOVA tables from hypothetical data. Path Analysis, Diallel-, TTC-, Line x Tester- and NCD analysis.

**UNIT I**

Centre of Origin, Species relationship; Floral biology; Breeding objectives and Breeding methods & achievements for cereal crops- Rice, Maize, *Shorghum*, Wheat, Barley.

**UNIT II**

Centre of Origin, Species relationship; Floral biology; Breeding objectives and Breeding methods & achievements for pulse crops- Urd, Mung, Chickpea, Fieldpea.

**UNIT III**

Centre of Origin, Species relationship; Floral biology; Breeding objectives and Breeding methods & achievements for oilseed crops: Rapeseed-Mustard and Groundnut.

**UNIT IV**

Centre of Origin, Species relationship; Floral biology; Breeding objectives and Breeding methods & achievements for **Fibre Crops**: Cotton.

**UNIT V**

Centre of Origin, Species relationship; Floral biology; Breeding objectives and Breeding methods & achievements for **Vegetables**: Potato, Tomato and Chillies.

**UNIT VI**

Centre of Origin, Species relationship; Floral biology; Breeding objectives and Breeding methods & achievements for **Cash crop**: Sugarcane.

**Practical**

Emasculation and hybridization techniques in different crop species;, Rice, Maize, Sorghum, Pearl Millet, Pigeonpea, Urdbean, Mungbean, Soyabean, Groundnut, Sesame, Castor, Cotton and Cowpea. Handling of segregating generation in pedigree, bulk and single seed decent method. Estimation of heterosis, inbreeding depression and heritability. Estimation of double cross yield from the data of single crosses.

**Theory****UNIT I**

Seed and Seed technology; Introduction, definition and importance;

**UNIT II**

Deterioration-causes of crop varieties and their control.

**UNIT III**

Physical and genetic purity analysis with their components;

**UNIT IV**

Seed quality; definition, characters of good quality seeds, different classes of seeds.

**UNIT V**

Multiplication of nuclear-, breeder-, foundation- and certified seeds.

**UNIT VI**

Seed certification, Phases of certification, procedure of certification & field inspection.

**UNIT VII**

Varietal identification through grow-out test and biochemical test. Seed testing, Seed treatment and importance.

**UNIT VIII**

Seed control order 1983, New Seed policy, factors affecting seed marketing; Role of WTO and OECD in seed marketing.

**Practical**

Seed sampling & testing: physical-, germination- and viability. Numerical problems on physical purity. Genetic purity test: grow-out test.

**Theory**

Breeding designer crops of families like Poaceae, Leguminosae, Brassicaceae & Solanaceae.  
Crop designing in relation to crop physiology.

**UNIT I**

Physical process of the cell. Basic concepts of Crop Physiology and their importance in Agriculture.

**UNIT II**

Soil minerals relation to crops: Macro and micro nutrients and their uptake, deficiency and toxicity symptoms, role and importance of fertilizer application, translocation of solutes & mechanism of water absorption by roots.

**UNIT III**

Growth and development, differentiation, hormonal concept of growth & differentiation, phytohormones and their physiological role, synthetic growth regulators and growth retardants.

**UNIT IV**

Photosynthesis: Mechanism of light reaction, CO<sub>2</sub> fixation in C<sub>3</sub>, C<sub>4</sub> and CAM plants and its significance.

**UNIT V**

Mitochondrial respiration: mechanism of anaerobic and aerobic respiration, photorespiration and RQ.

**Practical**

Mineral nutrients: Demonstration of energy requirements from ion uptake, deficiency symptoms of nutrients, radiant energy measurement, separation and quantification of chlorophylls, O<sub>2</sub> evolution during photosynthesis, measurements of gas exchange parameter, Photosynthetic rate, Photorespiration, Respiration rate, Estimation of reducing sugars and starch. Bioassay for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and Ethylene.

**Theory****UNIT I**

Historical aspects of heterosis-Nomenclature and definitions of heterosis- Heterosis in natural population and inbred population, Evolutionary aspects, Genetic consequences of selfing and crossing in self, cross-pollinated and asexually propagated crops.

**UNIT II**

Pre-Mendelian and Post-Mendelian ideas- Genetic theories of heterosis- Physiological, Biochemical and molecular factors underlying heterosis, theories and their estimations. Evolutionary concepts of heterosis.

**UNIT III**

Prediction of heterosis from various process – inbreeding depression, frequency of inbreeding and residual heterosis in F<sub>2</sub> and segregating populations, importance of breeding in exploitation of heterosis- case studies- Relationship between genetic distance and expression of heterosis- case studies, divergence and genetic distance analysis- morphological and molecular genetic distance in predicting heterosis. Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

**UNIT IV**

Types of male sterility and use in heterosis breeding, Maintenance, transfer and restoration of different type of male sterility use in hybrid seed production. Self-incompatibility, types and their use in hybrid seed production.

**UNIT V**

Organeller heterosis and complementation- creation of male sterility through genetic engineering and its exploitation in heterosis.

**UNIT VI**

Heterosis breeding in Wheat, Rice, Cotton, Maize, Pearl millet, Sorghum and oilseed Crops.

**Practical**

Maintenance of A, B, R lines and their use in hybrid seed production. Hybrid seed production by self-incompatible lines and compatible lines. Types of heterosis and their estimation. Prediction of double cross performance by the data of single crosses.

**Theory****UNIT I**

Ultrastructure of the typical plant cell; Difference between Eukaryotic and Prokaryotic cells, structure and function of cell wall, Plasma membrane and nuclear membrane.

**UNIT II**

Ultrastructure and functions of mitochondria, Chloroplast and other Photosynthetic organelles. Cell division and their types and Significance.

**UNIT III**

Genetic material in organisms; structure of nucleic acid, DNA replication and DNA repair, Genetic code and Protein synthesis.

**UNIT IV**

Transposable elements; mechanism of recombination in Prokaryotes, Gene amplification and its significance, Genes in development, Cancer and cell aging.

**Practical**

Ultrastructure of typical plant cell, Ultrastructure study of mitochondria, chloroplast and nucleus. Study of cell size, cell shape during mitotic and meiotic cell division. Study of nitrogenous bases with structural formulae in DNA & RNA; Study of nucleosides & nucleotides with structural formulae; genetic code and protein synthesis.

**Theory****UNIT I**

Plant biotechnology and its importance in crop improvement: definition, scope & history.

**UNIT II**

Totipotency and morphogenesis

**UNIT III**

Nutritional requirements & different types of media for plant tissue culture.

**UNIT IV**

Methods of plant tissue culture: meristem culture, micro-propagation, anther/pollen culture, ovule-ovary culture, embryo culture & embryo rescue technique, endosperm culture.

**UNIT V**

Protoplast culture and Somatic hybridization.

**UNIT VI**

Somatic embryogenesis and synthetic seed production technique.

**UNIT VII**

Use of enzymes and vectors in plant genetic engineering, gene transfer methods, molecular markers, QTLs and MAS.

**Practical**

Plant tissue culture laboratory, Nutritional requirements for plant tissue culture, different types of culture media *viz.*, MS, B5 and N<sub>6</sub>; Sterilization techniques, media preparation, different tissue culture methods *e.g.*, meristem culture, micropropagation, anther/pollen culture, ovule-ovary culture, embryo culture & embryo rescue. Hardening & acclimatization of regenerated plants.

**Theory****UNIT I**

Variety development and maintenance; Definition- variety, cultivar, extent variety, essentially derived variety, independently derived variety, reference variety, farmers variety, variety testing, release and notification systems in India and abroad.

**UNIT II**

DUS testing- DUS descriptors for major crops, Genetic purity concept and Maintenance breeding.

**UNIT III**

Factor responsible for genetic deterioration of varieties- safe guards during seed production. Maintenance of varieties in self and cross pollinated crops- isolation distance, principles of seed production. Methods of nucleus, breeder and foundation seed production.

**UNIT IV**

Seed multiplication- nucleus, breeder, foundation and certified. Quality seed production technology of self and cross pollinated crop varieties viz. Wheat, Barley, Paddy, Pearlmillet, Sorghum, Maize, Green gram, Black gram, Pigeonpea, Chickpea, Fieldpea, Groundnut, Sunflower, Rapeseed-mustard, Cotton, Berseem and Lucerne. Seed certification, procedure, seed loss and plant variety protection regulations in India and International systems.

**Practical**

Identification of suitable areas/locations for seed production. Identification of important weeds/objectionable weeds. Determination of isolation distance and planting ratio in different crops. Seed Production techniques of varieties of important crops given above portion.

**Course Title** : Experimental Statistics  
**Course No.** : AES 513  
**Credit Hours** : 3 (2+1)  
**Semester** : I

**Objective:** This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

#### **Theory**

**UNIT I:** Introduction to statistics and its applications in agriculture, classification, tabulation and graphical representation of data.

**UNIT II:** Arithmetic mean, median, mode, standard deviation and coefficient of variation, moments, measures of Skewness & Kurtosis.

**UNIT III:** Concept of sampling, different sampling methods, sampling versus complete enumeration, simple random sampling with and without replacement, Use of random number tables for selection of simple random sample, stratified random sampling.

**UNIT VI:** Test of significance, Z-test and t-test for Means (One sample & two samples), F-test, Chi-square test of independence of attributes in  $2 \times 2$  contingency table.

**UNIT V:** Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**UNIT VI:** Experimental designs, need for designing of experiments, characteristics of a good design. Basic principles of designs, randomization, replication and local control, uniformity trials, size and shape of plots and blocks; Analysis of variance, Completely randomized design, randomized block design and Latin square design, Split plot and strip plot designs; missing plot technique in randomized block and Latin square design, factorial experiments (without confounding) in  $2^3$  designs.

#### **Practical**

- Application of Z-test.
- Application of t-test.
- Application of F-test.
- Chi-Square test of Goodness of Fit.
- Chi-Square test of Independence of Attributes for  $2 \times 2$  contingency table.
- Analysis of Variance One Way Classification.
- Analysis of Variance Two Way Classification.
- Selection of random sample using Simple Random Sampling.
- Correlation & Regression Analysis.
- Analysis of CRD, RBD and LSD

**UNIT 1:** Genetic diversity analysis- metroglyph, cluster and  $D^2$  analysis. Association analysis- phenotypic and genotypic correlation, path analysis and parent-progeny regression analysis and genetic divergence. Selection indices- selection of parents, Simultaneous model, selection model, concept of selection, heritability and genetic advance. Selection differential and response to selection, correlated response, principal component and discriminant function analysis.

**UNIT 2:** Mating design, Diallel analysis- Griffing's method 1 and 2. Hayman's graphical approach, North Carolina Design (NCD) and their interpretation – Line X tester analysis and triple test cross. Estimation of heterosis and inbreeding depression, concept of combining ability analysis and nature of gene action- additive, dominance, epistasis and linkage. Treating the plant propagules at different doses of physical and chemical mutagens, visit to radio-isotope laboratory, Mutagenic effectiveness and efficiency, Mutation breeding in cereals and pulses.

**UNIT 3:** Basic principles of design of experiment, Analysis of variance and covariance, completely randomized design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD), Missing plot technique, Factorial experiment, Split plot and strip plot design. Preparation of layout plans, and field visits related to application of these designs. Null hypothesis, Alternate hypothesis, Test of significance, z-, t- &  $X^2$  (Chi-square) tests, non-parametric tests.

**UNIT 4:** History of Cytology, cell structure, cell division. Nucleolus: Structure & Function; Basis of Heredity: Chemical and Physical; Basic knowledge of nucleic acids; Forms of Chromosomes, chromosomal aberrations, linkage, crossing over and gene mapping; Alleles and pleiotropism; Lethal genes; Mendelian principles and gene interaction; Multiple factor; Sex determination; Extracellular inheritance; Mutation: Nature & Causes. Transcription, Translation and gene-regulation. Population Genetics.

**UNIT 5:** Nature & scope of plant breeding, Plant Introduction & domestication. Reproductive systems; Genetic basis of breeding methods with self & cross pollinated crops; Introduction, Selection, Hybridization, Multiple crossing, Back cross and other approaches; Breeding methods for asexually propagated crops; Systems of mating with respect to selection, heterosis and inbreeding depression; Self-incompatibility and male-sterility; Hybrid, Synthetic and Composite varieties; Recurrent selection; Classes of quality seeds, maintenance & multiplication of Nucleus, Breeder, Foundation & Certified Seeds. Varietal deterioration and their control. Seed viability test (Tz test). Biotechnology in crop improvement.

# Name of Programme: M.Sc. (Ag.) Horticulture

Academic eligibility for admission: - B.Sc. (Ag. / Hort.)

## Curriculum and Syllabus

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
I <sup>st</sup> Sem.	HORT 501	Propagation and Nursery management of Fruit Crops	3 (2 + 1)	20	50	30	100
	HORT 502	Landscaping and Ornamental Gardening	3 (2 + 1)	20	50	30	100
	HORT 503	Tropical and Dry land Horticulture	3 (2 + 1)	20	50	30	100
	AES 513	Experimental Statistics	3 (2 + 1)	20	50	30	100
	Total			12			

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
II <sup>nd</sup> Sem.	HORT 504	Production Technology of cool season vegetable crops	3 (2 + 1)	20	50	30	100
	HORT 505	Sub-Tropical and Temperate Fruit Production	3 (2 + 1)	20	50	30	100
	HORT 506	Production Technology of cut & loose flowers	3 (2 + 1)	20	50	30	100
	HORT 507	Seed Production Technology of vegetable crops	3 (2 + 1)	20	50	30	100
	Total			12			

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
III <sup>rd</sup> Sem.	HORT 508	Production Technology of warm season Vegetable Crops	3 (2 + 1)	20	50	30	100
	HORT 509	Protected cultivation of Horticultural crops	2 (1 + 1)	20	50	30	100
	HORT 510	Breeding of Horticultural crops	3 (2 + 1)	20	50	30	100
	HORT 511	Post Harvest Technology for of Horticultural crops	3 (2 + 1)	20	50	30	100
	Total			11			

Semester	Course Code	Course Title	Credit Hrs	Evaluation Marks			Total
				Mid Term	End Term	Practical	
IV <sup>th</sup> Sem.	HORT 591	Master's Seminar	1 (0+1)	-	-	100	100
	HORT 599	Master's Research	20	-	-	-	S*
	Or Research Methodology						
Total			21				
Grand Total			56				

*Handwritten signatures and notes:*  
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 [Signatures: H. S. ... , B. S. ... , K. S. ... , R. S. ... , S. S. ... , M. S. ... , P. S. ... , D. S. ... , N. S. ... , H. S. ... ]  
 [Notes: "S\* is ...", "Research Methodology", "Grand Total 56"]

**Objective:** Familiarization with principles and practices of propagation and nursery management for fruit crops.

### **Theory**

UNIT I: Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II: Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT III: Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT IV: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT V: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

**Practical:** Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

## **HORT 502 LANDSCAPING AND ORNAMENTAL GARDENING 3(2+1)**

**Objective:** Familiarization with principles and practices of landscaping and ornamental gardening.

### **Theory**

UNIT I: Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II: Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

UNIT III: Garden plant components, arboretum, shrubbery, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds.

UNIT IV: Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, temple garden.

UNIT V: Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

**Practical:** Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

### **HORT 503 TROPICAL AND DRY LAND FRUIT PRODUCTION 3(2+1)**

**Objective:** To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

**Theory:** Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, pollination, fruit set and development, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

#### **Crops**

UNIT I: Mango and Banana

UNIT II: Citrus and Papaya

UNIT III: Guava, Sapota and Jackfruit

UNIT IV: Pineapple, Annonas and Avocado

UNIT V: Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

**Practical:** Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing commercial orchards.

### **HORT 504 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 3(2+1)**

**Objective:** To educate production technology of cool season vegetables.

**Theory:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

### **Crops**

UNIT I: Potato

UNIT II: Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout

UNIT III: Root crops: carrot, radish, turnip and beetroot

UNIT IV: Bulb crops: onion and garlic

UNIT V: Peas and broad bean, green leafy cool season vegetables

**Practical:** Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

## **HORT 505 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 3(2+1)**

**Objective:** To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

**Theory:** Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, pollination, fruit set and development, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

### **Crops**

UNIT I: Apple, pear, quince, grapes

UNIT II: Plums, peach, apricot, cherries, hazelnut

UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT IV: Nuts- walnut, almond, pistachio, pecan

UNIT V: Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

**Practical:** Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

## **HORT 506 PRODUCTION TECHNOLOGY OF CUT & LOOSE FLOWERS 3(2+1)**

**Objective:** To impart basic knowledge about the importance and production technology of cut flowers grown in India.

### **Theory**

**UNIT I:** Scope of cut flowers in global trade, Global Scenario of cut and loose flower production, Varietal wealth and diversity, area under cut and loose flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

**UNIT II:** Growing environment, open cultivation of cut and loose flowers, soil requirements, field preparation, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO<sub>2</sub> on growth and flowering.

**UNIT III:** Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

**UNIT IV:** Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

**UNIT V:** Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

**Crops:** Rose, Chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, lilliums, as cut flowers nyctanthes jasmine, marigold, crosandra, celosia, gamphrena as loose flower.

**Practical:** Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

## **HORT 507 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 3(2+1)**

**UNIT I:** Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

**UNIT II:** Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behavior, seed Development and maturation; methods of hybrid seed production.

**UNIT III:** Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

**UNIT IV:** Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packing (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

**UNIT V:** Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

**Practical:** Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of offtype; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

## **HORT 508 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 3(2+1)**

**Objective:** To teach production technology of warm season vegetables.

**Theory:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of:

### **Crops**

**UNIT I:** Tomato, eggplant, hot and sweet peppers

UNIT II: Okra, beans, cowpea and clusterbean

UNIT III: Cucurbitaceous crops

UNIT IV: Tapioca and sweet potato

UNIT V: Green leafy warm season vegetables

**Practical:** Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

**HORT 509 PROTECTED CULTIVATION OF HORTICULTURAL CROPS 2(1+1)**

**Objective:** Understanding the principles, theoretical aspects and developing skills in protected cultivation of fruit crops.

**Theory**

UNIT I: Importance and scope of protected cultivation, World scenario, Indian situation: present and future scope, Principles used in Protected cultivation, energy management, low cost structures.

UNIT II: Regulatory structures used in protected structures types of – greenhouse/polyhouse/nethouse, Hot beds, cold frames, effect of environmental factors viz light, temperature, humidity and CO<sub>2</sub> on growth of different vegetables, flowers and fruits, manipulation of light, temperature, humidity and CO<sub>2</sub> for production of horticultural crops installation of micro irrigation and fertilization.

UNIT III: Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.

UNIT IV: Regulation of flowering and fruiting in horticultural crops, Technology for raising tomato, sweet pepper, cucurbit crops, gerbera, rose, chrysanthemum and strawberry in Protected structures, training and staking in protected crops, varieties and hybrids suitable for growing in protected structures.

## UNIT-5

Problem of growing horticultural crops in protected structures and their remedies, insect and disease management in protected structures;

### Practical

Study of various types of structures, methods to control temperature, CO<sub>2</sub> and light, media, training and pruning, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/nct house/shade house in the region.

HORT 510

### III<sup>rd</sup> Semester BREEDING OF HORTICULTURAL CROPS

3(2+1)

**Theory** Origin, botany, taxonomy, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, issue of patenting, PPVFR act. achievement and future trust in following selected crops.

#### Unit I

Mango, papaya, banana, grape and citrus fruits.

#### Unit II

Potato, tomato, brinjal, hot pepper and sweet pepper.

#### Unit III

Okra, Pea and beans.

#### Unit IV

Gourds, melons, pumpkins and squashes

#### Unit V

Cabbage, cauliflower, carrot, beetroot, radish.

### Practical

Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, cytological studies, selfing and crossing techniques in horticulture crops; hybrid seed production of vegetable crops in bulk, screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; Visit to breeding blocks.



**Course Title** : Experimental Statistics  
**Course No.** : AES 513  
**Credit Hours** : 3 (2+1)  
**Semester** : I

**Objective:** This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

#### **Theory**

**UNIT I:** Introduction to statistics and its applications in agriculture, classification, tabulation and graphical representation of data.

**UNIT II:** Arithmetic mean, median, mode, standard deviation and coefficient of variation, moments, measures of Skewness & Kurtosis.

**UNIT III:** Concept of sampling, different sampling methods, sampling versus complete enumeration, simple random sampling with and without replacement, Use of random number tables for selection of simple random sample, stratified random sampling.

**UNIT VI:** Test of significance, Z-test and t-test for Means (One sample & two samples), F-test, Chi-square test of independence of attributes in  $2 \times 2$  contingency table.

**UNIT V:** Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**UNIT VI:** Experimental designs, need for designing of experiments, characteristics of a good design. Basic principles of designs, randomization, replication and local control, uniformity trials, size and shape of plots and blocks; Analysis of variance, Completely randomized design, randomized block design and Latin square design, Split plot and strip plot designs; missing plot technique in randomized block and Latin square design, factorial experiments (without confounding) in  $2^3$  designs.

#### **Practical**

- Application of Z-test.
- Application of t-test.
- Application of F-test.
- Chi-Square test of Goodness of Fit.
- Chi-Square test of Independence of Attributes for  $2 \times 2$  contingency table.
- Analysis of Variance One Way Classification.
- Analysis of Variance Two Way Classification.
- Selection of random sample using Simple Random Sampling.
- Correlation & Regression Analysis.
- Analysis of CRD, RBD and LSD

**UNIT I: Research Methodology at a glance**

Importance and scope of research in Horticulture for agricultural development. Objective of research, Requirement of research, Research planning, Characteristics of a research planning programme, Research problem, Steps for identifying a research problem.

**UNIT II: Field Plot Techniques**

Principles of experimental design, Important design for field experimentation- Completely randomized design, Randomized block design and Latin square design, Planning and analysis of factorial experiments, Split plot design, confounding- complete and partial. Layout of the field, Deciding plot size,

**UNIT III: Recording of data or Observation**

Rainfall, temperature, sunshine, and relative humidity, Soil analysis: Texture, bulk density, pH, organic carbon; Biometric observation – Germination & Survival percent, Growth parameters, Yield and Yield attributing Traits and Qualitative traits.

**UNIT IV: Horticultural Research Trials**

Study of different horticultural research trials conducted by government and private institutions. Prepare a report on horticultural research trials by partitioning it in Introduction, Objective, Review of Literature and their citation, Technical programme, observation to be recorded and Possible outcomes.

**UNIT V: Data Presentation and Writing Skills**

Diagrammatic presentation and its types, Collection of review of literature, Writing of bibliography, Preparation of synopsis. Writing of Abstract, Research paper, Popular articles, Presentation of research paper.