

**NEW AND RESTRUCTURED
POST-GRADUATE CURRICULA & SYLLABUS**

Agricultural Economics
Agricultural Extension
Genetic & Plant Breeding
Horticulture
Soil Science & Agricultural Chemistry
w.e.f. 2017-18
Semester System
As per ICAR



Submitted by :

Convener Board of Studies in Agriculture

Kulbhaskar Ashram P.G. College, Allahabad - 211001

Affiliated Allahabad State University

Allahabad - 211001

AGRICULTURAL ECONOMICS

Code No.	Course Title	Credit
Major Courses		
	Total	
Minor Courses		
	Total	
Supporting Courses		
	Total	
Non Credit Compulsory Courses		
Semester wise Distribution:		
Ist Semester		
	Total	
IInd Semester		
	Total	
IIIrd Semester		
	Total	
IVth Semester		
	Total	
	G.Total	

Course Contents

AES 501 MICRO ECONOMIC THEORY AND APPLICATIONS

2(2+0)

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.

Suggested Readings

David M Kreps 1990. *A Course in Microeconomic Theory*. Princeton University Press.

Dewitt KK. 2002. *Modern Economic Theory*. Sultan Chand & Co.

Henderson JM & Quandt RE. 2000. *Microeconomic Theory: A Mathematical Approach*. McGraw-Hill.

Koutsoyiannis A. 2003. *Modern Microeconomics*. The Macmillan Press.

Silberberg E & Suen W. 2001. *The Structure of Economics - A Mathematical Analysis*. McGraw-Hill.

Varian Hal R. 1999. *Intermediate Microeconomics*. Affiliated East-West Press.

AES 502 MACRO ECONOMICS AND POLICY

2(2+0)

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: 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.

Suggested Readings

- Ahuja HL. 2007. *Macroeconomics: Theory and Policy*. S. Chand & Co.
- Eugene A Diulio 2006. *Macroeconomics*. 4th Ed. Schaums' Outlines.
- Gardner Ackely 1987. *Macro Economic: Theory and Policy*. Collier Macmillan.
- Dornbusch. 2006. *Macroeconomics*. McGraw Hill Publication

AES 504

AGRICULTURAL PRODUCTION ECONOMICS

2(1+1)

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: 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 IV: 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 - specification, estimation and interpretation of production functions – returns to scale, factor shares, elasticity of production - physical optima-economic optima-least cost combination- optimal product choice- cost function estimation, interpretation-estimation of yield gap - incorporation of technology in production functions- measuring returns to scale risk analysis through linear programming.

Suggested Readings

Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.

Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*. John Wiley & Sons.

Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics*. Vol. I. *Agricultural Production*. Elsevier.

Heady EO. *Economics of Agricultural Production and Resource Use*. Prentice- Hall.

Sankayan PL. 1983. *Introduction to Farm Management*. Tata Mc Graw Hill.

AES 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 3(2+1)

Objective: To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

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 elasticities 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.

Suggested Readings

Purecell WD & Koontz SR. 1999. *Agricultural Futures and Options: Principles and Strategies*. 2nd Ed. Prentice-Hall.

Rhodes VJ. 1978. *The Agricultural Marketing System*. Grid Publ., Ohio.

Shepherd SG & Gene AF. 1982. *Marketing Farm Products*. Iowa State Univ. Press.

Singhal AK. 1986. *Agricultural Marketing in India*. Annual Publ., New Delhi.

AES 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 2(1+1)

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 Course Objective and 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 – sources of data – methods of collection of data. Methods of sampling – criteria to choose – discussion on sampling under different situations. Scaling Techniques – measurement of scales. Preparation of interview schedule - 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. Presentation of the results.

Suggested Readings

Black TR. 1993. *Evaluating Social Science Research - An Introduction*. SAGE Publ.

Creswell JW. 1999. *Research Design - Qualitative and Quantitative Approaches*. SAGE Publ.

Dhondyal SP. 1997. *Research Methodology in Social Sciences and Essentials of Thesis Writing*. Amman Publ. House, New Delhi.

Kothari CR. 2004. *Research Methodology - Methods and Techniques*. Wishwa Prakashan, Chennai.

Rao KV. 1993. *Research Methodology in Commerce and Management*. Sterling Publ., New Delhi.

Singh AK. 1993. *Tests, Measurements and Research Methods in Behavioural Sciences*. Tata McGraw-Hill.

Venkatasubramanian V. 1999. *Introduction to Research Methodology in Agricultural and Biological Sciences*. SAGE Publ.

AES 508

LINEAR PROGRAMMING

2(1+1)

Objective: The Course Objective of the course is to impart knowledge of Linear programming techniques.

Theory

UNIT I: Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, use 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 minimization problems. Formulation of farm 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: Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of the simplex matrices for typical farm situations.

Suggested Readings

Dorfman R. 1996. *Linear Programming & Economic Analysis*. McGraw Hill.

Loomba NP. 2006. *Linear Programming*. Tata McGraw Hill.

Shenoy G. 1989. *Linear Programming-Principles & Applications*. Wiley Eastern Publ.

Vaserstein. 2006. *Introduction to Linear Programming*. Pearson Education Publication

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 and Over dues and Loan waiving- : An overview, 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.

Suggested Readings

- Dhubashi PR. 1986. *Policy and Performance - Agricultural and Rural Development in Post Independent India*. Sage Publ.
- Gittinger JP 1982. *Economic Analysis of Agricultural Projects*. The Johns Hopkins Univ. Press.
- Gupta SC. 1987. *Development Banking for Rural Development*. Deep & Deep Publ.

Little IMD & Mirlees JA. 1974 *Project Appraisal and Planning for Developing Countries*. Oxford & IBH Publ

Muniraj R. 1987 *Farm Finance for Development* Oxford & IBH Publ.

Research:

M.Sc. (Ag.) Students should submit thesis as research work of 15 credits.

AGRICULTURAL EXTENSION

Code No.	Course Title	Credit
Major Courses		
	Total	
Minor Courses		
	Total	
Supporting Courses		
	Total	
Non Credit Compulsory Courses		
Semester wise Distribution:		
Ist Semester		
	Total	
IInd Semester		
	Total	
IIIrd Semester		
	Total	
IVth Semester		
	Total	
	G.Total	

Course contents

AEX- 501: DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION 1+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.

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. *Extension Education What? And What Not ?* RBSA Publ.

Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Process based on Non-Formal Education Methods*. Global EPM Facility, FAO.

Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education*. Associated Publishing Co.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ.

Khan PM. 2002. *Textbook of Extension Education*. Himalaya Publ.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.

Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension* .2nd Ed. CBS.

Viswanathan M. 1994. *Women in Agriculture and Rural Development*. Printwell Publ.

AEX- 502: DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT 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.

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development*. Oxford & IBH.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agrotech Publ. Academy.

Jana BL & Mitra KP. 2005. *Farm Journalism*. Agrotech Publ. Academy.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.

Rayudu CS. 2002. *Communication*. Himalaya Publ. House.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Sandhu AS. 2004. *Textbook on Agricultural Communication Process and Methods*. Oxford & IBH.

AEX- 504: RESEARCH METHODS IN BEHAVIOURAL SCIENCE

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.

Suggested Readings

Chandrakandan K, Venkataprabu J, Sekar V & Anand Kumar V. 2000. *Tests and Measurements in Social Research*. APH Publ.

Kerlinger FN. 1973. *Foundations of Behavioural Research*. Holt Rhinehart.

Kothari CR.1984. *Research Methodology, Methods and Techniques*. Chaitanya Publ. House.

Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in Social Sciences*. Himalaya Publ. House.

Mulay S & Sabaratnam VE.1983. *Research Methods in Extension Education*. Manasavan.

Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners*. Sage Publ.

Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education*. Naya Prokash.

Wilkinson TS & Bhandarkar PC.1993. *Methodology and Techniques of Social Research*. Himalaya Publ.Home.

AEX- 507: HUMAN RESOURCE DEVELOPMENT (HRD)

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.

Suggested Readings

- Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.
- David Gross. 1997. *Human Resource Management - The Basics*. TR Publ.
- Davis Keth & Newston W John 1989. *Human Behaviour at Work*. 8th Ed. McGraw-Hill.
- Hersey Paul & Balanchard H Kenneth. 1992. *Management of Organizational Behaviour Utilizing Human Resource*. 5th Ed. Prentice-Hall of India.
- Knoontz Harold & Weihrich Heinz 1990. *Essentials of Management*. 5th Ed. McGraw-Hill.
- Lynton RP & Pareek U. 1993. *Training for Development*. DB. Taraporewale Sons & Co.
- Punna Rao P & Sudarshan Reddy M. 2001. *Human Resource Development Mechanisms for Extension Organization*. Kalyani Publ.
- Rao TV. 2003. *Readings in Human Resource Development*. Oxford Publ.Co.
- Silberman Mel. 1995. *Active Training*. Press Johnston Publ. Co., New Delhi.
- Singh RP. 2000. *Management of Training Programmes*. Anmol Publ.
- Subba Rao P. 2005. *Management & Organizational Behaviour*. Himalaya Publ. House.
- Sundaram RM, Gupta V, George SS. 2006. *Case Studies in Human Resource Management*. ICFAI, Hyderabad.

Tripati & Reddy. 2004. *Principles of Management*. Tata McGraw-Hill.

Wayne MR & Robert MN. 2005. *Human Resource Management*. International Ed. Pearson Prentice Hall.

AEX- 503: DIFFUSION AND ADOPTION OF INNOVATIONS

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.

Suggested Readings

Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*. Wiley Eastern.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management In Extension*.
Concept Publ. Co.

Ray GL. 2005. *Extension Communication and Management*. Kalyani Publ.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

AEX- 506: ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION 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.

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.

Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.

Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co.

Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.

Tripathi PC & Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.

Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

AEX 505: E-EXTENSION

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.

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development- Cases from India*. Sage Publ.

Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical*. Ganga- Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information – A Guide to Information Technology*. The World Bank, Washington.

M.Sc(Ag): Genetics & Plant Breeding

Code No.	Course Title	Credit
Major Courses		
GPB-501*	Principles of Genetics	2+1
GPB-502*	Principles of Cytogenetics	2+1
GPB-503*	Principles of Plant Breeding	2+1
GPB-504*	Principles of Quantitative Genetics	2+1
GPB-508	Cell Biology and Molecular Genetics	2+1
GPB-509	Biotechnology for Crop Improvement	2+1
GPB-514	Breeding of field crops	2+0
	Total	20
Minor Courses		
ABT-501	Principles of Biotechnology	2+1
ABC-505	Biochemical Techniques	1+2
PPA-505	Detection and Diagnosis of Plant Diseases	0+2
ENT-518	Techniques in Plant Protection	0+1
	Total	9
Supporting Courses		
SST-502	Principles of Seed Production	2+0
AES-512	Experimental design	2+1
	Total	5
Non Credit Compulsory Courses		
Semester wise Distribution:		
Ist Semester		
ABT-501	Principles of Biotechnology	2+1
GPB-501*	Principles of Genetics	2+1
GPB-502*	Principles of Cytogenetics	2+1
PPA-505	Detection and Diagnosis of Plant Diseases	0+2
AES-512	Experimental design	2+1
	Total	14
IInd Semester		
GPB-503*	Principles of Plant Breeding	2+1
GPB-504*	Principles of Quantitative Genetics	2+1
ABC-505	Biochemical Techniques	1+2
GPB-591	Seminar	1+0
	Total	10
IIIrd Semester		
GPB-508	Cell Biology and Molecular Genetics	2+1
GPB-514	Breeding of Field Crops	1+1
SST-502	Principles of Seed Production	2+0
ENT-518	Techniques in Plant Protection	0+1
	Total	8
IVth Semester		
GPB-509	Biotechnology for Crop Improvement	2+1
GPF-899	Masters Research	20
	Total	23
	G.Total	55

GENETICS AND PLANT BREEDING

Course Contents

GPB 501 **PRINCIPLES OF GENETICS** **2+1**

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

UNIT I

Beginning of genetics; Early concepts of inheritance; Mendel's laws; Discussion on Mendel's paper; Chromosomal theory of inheritance.

UNIT II

Multiple alleles; Gene interactions; Sex determination, 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

Population-Mendelian population-Random mating population-Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

UNIT IV

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes; Genetic code; Protein biosynthesis.

UNIT V

Genetic fine structure analysis; Allelic complementation; Split genes; Transposable genetic elements; Overlapping genes; Pseudogenes; Oncogenes; Gene families and clusters.

UNIT VI

Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation; Repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression; Gene regulation in eukaryotes; RNA editing.

UNIT VII

Gene isolation, synthesis and cloning; Genomic and cDNA libraries; PCR-based cloning, positional cloning; Nucleic acid hybridization and immuno-chemical detection; DNA sequencing; DNA restriction and modification; Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

UNIT VIII

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT IX

Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; Genetics of mitochondria and chloroplasts.

UNIT X

Concepts of Eugenics; Epigenetics; Genetic disorders and behavioural genetics.

Practical

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; 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 isozymes-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

2+1

Objectives

To provide insight into structure and functions of chromosomes, chromosomes mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

UNIT I

Architecture of chromosome 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

Cell structure; Cell cycle; Cell division-mitosis and meiosis; Differences, significance and deviations-Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes;

Crossing over-mechanisms and theories of crossing over–recombination models, cytological basis, -Variation in chromosome structure; Evolutionary significance-Introduction to 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, diploids and polyploids; Utilization of aneuploids 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

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids-Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer-Alien addition and substitution lines-creation and utilization; Apomixis-Evolutionary and genetic problems in crops with apomixes.

UNIT V

Reversion of autopolyploids to diploids; Genome mapping in polyploids-Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, *triticale* and *brassica*)-Hybrids between species with same chromosome number, alien translocations-Hybrids between species with different chromosome number; Gene transfer using amphidiploids-Bridge species.

UNIT VI

Fertilization barriers in crop plants at pre-and post-fertilization levels- *in vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization; case studies- Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc.-Microscopy: various types of microscopes, -Observing sections of specimen using electron microscope; Preparing specimen for observation-Fixative preparation and fixing specimen for light microscopy studies in cereals- Studies on the course of mitosis in wheat, pearl millet- Studies on the course of mitosis in onion and *Aloe vera*- Studies on the course of meiosis in cereals, millets and pulses- Studies on the course of meiosis in oilseeds and forage crops- Using micrometers and studying the pollen grain size in various crops-Various methods of staining and preparation of temporary and permanent slides- Pollen germination *in vivo* and *in vitro*; Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level-Identification of polyploids in different crops- Induction and identification of haploids; Anther culture and ovule culture- Morphological observations on synthesized autopolyploids-Observations on C-mitosis, learning on the dynamics of spindle fibre assembly- Morphological observations on allopolyploids- Morphological observations on aneuploids –Cytogenetic analysis

of interspecific and intergeneric crosses- Maintenance of cytogenetic stocks and their importance in crop breeding- Various ploidy levels due to somaclonal variation; Polyploidy in ornamental crops,-Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization (GISH)

GPB 503

PRINCIPLES OF PLANT BREEDING

2+1

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; S₁ and S₂ 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.

GPB 504

PRINCIPLES OF QUANTITATIVE GENETICS

2+1

Objectives

To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Theory

UNIT I

Mendelian traits vs polygenic traits-nature of quantitative traits and its inheritance-Multiple factor hypothesis-analysis of continuous variation; Variations associated with polygenic traits-phenotypic, genotypic and environmental-non-allelic interactions; Nature of gene action-additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Analysis of Variance (ANOVA)-Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments-principles and applications; Genetic diversity analysis-metroglyph, cluster and D² analyses-Association analysis-phenotypic and genotypic correlations; Path analysis and parent-progeny regression analysis; Discriminant function and principal component analyses; Selection indices-selection of parents; Simultaneous selection models-concepts of selection-heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs-Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction-adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis- principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping-desired populations for QTL mapping- statistical methods in QTL mapping-QTL mapping in genetic analysis; Marker assisted selection (MAS)-Approaches to apply MAS in plant breeding-selection based on marker-simultaneous selection based on marker and phenotype-factors influencing MAS.

Practical

Problems on multiple factors inheritance-partitioning of variance-Estimation of heritability and genetic advance-Covariance analysis-Metroglyph analysis-D² analysis-Grouping of clusters and interpretation-Cluster analysis-Construction of cluster diagrams and dendrograms-interpretation-correlation analysis-Path analysis-Parent-progeny regression analysis-Diallel analysis: Griffing's methods I and II-Diallel analysis: Hayman's graphical approach-Diallel analysis: interpretation of results-NCD and their interpretations-Line x tester analysis and interpretation results-Estimation of heterosis: standard, mid-parental and better-parental heterosis-Estimation of inbreeding depression-Generation mean analysis: Analytical part and interpretation-Estimation of different types of gene actions.

Partitioning of phenotypic variance and co-variance into components due to genotypes, environments and genotype x environment interactions- Construction of saturated linkage maps and QTL mapping-Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and marker linkage studies-Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC)-use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model-Principal component analysis model-Additive and multiplicative model-Shifted multiplicative model-Analysis and selection of genotypes-Methods and steps to select the best model-Selection systems-Biplots and mapping genotypes.

GPB 508 CELL BIOLOGY AND MOLECULAR GENETICS 2+1

Objective

To impart knowledge in theory and practice about cell structure, organelles and their functions.

Theory

UNIT I

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular organelles-nucleus, plastids-chloro/chromoplast, mitochondria, endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II

Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus-Structure and chemical composition; Cell division and physiology of cell division.

UNIT III

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation-Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes-ribosomes, t-RNAs and translational factors.

UNIT IV

Transposable elements; Mechanisms of recombination in prokaryotes; DNA organization in eukaryotic chromosomes-DNA content variation, types of DNA sequences-Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Gene in development; Cancer and cell aging.

Practical

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method; Determination of soluble protein content in a bacterial culture.

Isolation, purification and raising of clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

GPB 509

BIOTECHNOLOGY FOR CROP IMPROVEMENT

2+1

Objective

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II

Tissue culture-History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc), mapping populations (F₂s, back crosses, RILs, NILs and DH)

UNIT IV

Molecular mapping and tagging of agronomically important traits, Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTL analysis in crop plants, Gene pyramiding.

UNIT V

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer, Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII

MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights.

UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture-Media components and media preparation-Aseptic manipulation of various explants; observations on the contaminants occurring in media-interpretations-Inoculation of explants; Callus induction and plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures-Visit to commercial micropropagation unit.

Transformation using *Agrobacterium* strains, GUS assay in transformed cells/tissues; DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring

and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

GPB 514 BREEDING OF FIELD CROPS 1+1

Objective

Keeping in view the credit load of the course, course syllabus may be synthesized of both kharif and rabi seasons major crops as follows:-

THEORY

Centers of origin Distribution of species, wild relatives in different cereals, pulses, oil seeds, fibers, fodder and cash crops; vegetables and horticultural crops, plant genetic resources, its utilization and conservation; floral biology of major crops of different groups namely viz. maize, Rice, sorghum pearl millet, pigeonpea, Mungbean, urd bean, grass pea, lentil, groundnut, rapeseed, mustard, sisam, cotton and tobacco.

Practical

Endemism and hybridization techniques different crops namely, wheat, sunflower, tomato, maize, Rice, rapeseed mustard, pigeonpea, urdbean, chickpea, cotton and tobacco.

Horticulture

Minimum Credit Requirements:

<u>Subject</u>	<u>Credit</u>	<u>Actual Credits</u>
Major	20	21
Minor	09	09
Supporting	05	06
Seminar	01	01
Research	20	20
Total Credits	55	57

- Major Subject** : The subject (Reptt.) in which the students take admission.
- Minor Subject** : The subject closely related to major subject (Plant Pathology, Entomology, Agronomy, Soil Science etc.)
- Supporting Subject** : The subject not related to major subject. It could be any subject considered relevant for students research work (i.e. Statistics)
- Non-Credit** : (PGS501-PGS506) six courses are of general nature and are compulsory for Master's programme.

Horticulture

Ist Semester Courses	:		
HOR 505	:	Propagation and Nursery Management of fruit Crops	(2+1)
Hor 504	:	Landscaping and Ornamental Gardening	(2+1)
Minor Subject	:	One course : Any related to major subject	(2+1)
IInd Semester Course	:		
HOR 501	:	Production Technology of cool season Vegetable	(2+1)
HOR 502	:	Subtropical and Temperate fruit production	(2+1)
Minor Subject	:	One course : any related to major subject	(2+1)
IIIrd Semester Course	:		
HOR 502	:	Production Technology of warm season vegetable crops	(2+1)
HOR 503	:	Production Technology for loose flowers	(2+1)
Minor Subject	:	One course : any related to major subject	(2+1)
IVth Semester Course	:		
HOR 502	:	Production technology of cut flowers	(2+1)
Supporting Subject	:	Related to research work	(5)

Horticulture

PROPAGATION AND NURSERY MANAGEMENT 2+1

HOR 501

Ist Semester

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, apomixes, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II

Seed quality, treatment, packing, storage, certification, testing. 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 – Progenyorchard 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.

HOR 502

LANDSCAPING AND ORNAMENTAL GARDENING 2+1

Ist Semester

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, demsites, IT parks, corporates.

UNIT III

Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.

UNIT IV

Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

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.

VEGETABLE SCIENCE

Course Contents

HOR 503 **PRODUCTION TECHNOLOGY OF COOL SEASON** **2+1**
IInd Semester

VEGETABLE CROPS

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:

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 economic; 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.

HOR 501 **4SUBTROPICAL AND TEMPERATURE FRUIT PRODUCTION 2+1**
IInd Semester

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, physiology of flowering, fruit set and development, abiotic factors limiting production,

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 Zone (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.

HOR 505

PRODUCTION TECHNOLOGY OF WARM SEASON

2+1

IIIrd Semester

VEGETABLE CROPS

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 :

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.

HOR 506

PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS 2+1

IIIrd Semester

Objective

To impart basic knowledge about the importance and management of loose flowers grown in India

Unit I-

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques.

Unit II-

Soil and climate requirements, field preparation, systems of planting, precision farming techniques.

Unit III

Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM an IDM.

Unit IV

Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

Unit V

Harvest indices, harvesting techniques, post-harvest handling and garding, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agri Export Zones.

Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose,

crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

Practical

Botanical description of species and 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, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets.

HOR 507

PRODUCTION TECHNOLOGY OF CUT FLOWERS 2+1

IVth Semester

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 flower production, Varietal wealth and diversity, area under cut flowers and production problems in India-Patent rights, nursery management, media for nursery, special nursery practices.

Unit II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO₂ 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: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, lilioms, bird of paradise, heliconia, alstroemeria, a;inia, orramental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical Botanical description of varieties, propagation techniques, mist chamber operation, traning 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.