AGRICULTURAL ECONOMICS

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
AG ECON 501*	MICRO ECONOMIC THEORY AND APPLICATIONS	2+0	I
AG ECON 502*	MACRO ECONOMIC THEORY	2+0	I
AG ECON 503	EVOLUTION OF ECONOMIC THOUGHT	1+0	II
AG ECON 504*	FARM MANAGEMENT AND AGRICULTURAL PRODUCTION ECONOMICS	2+1	I
AG ECON 505*	AGRICULTURAL MARKETING AND PRICE ANALYSIS	2+1	I
AG ECON 506*	RESEARCH METHODOLOGY FOR SOCIAL SCIENCES	1+1	II
AG ECON 507*	PRINICIPLES OF ECONOMETRICS	2+1	I
AG ECON 508*	LINEAR PROGRAMMING	1+1	II
AG ECON 509	AGRICULTURAL FINANCE AND PROJECT MANAGEMENT	2+1	II
AG ECON 510/ ❶ SST 514	SEED MARKETING AND MANAGEMENT	2+1	II
AG ECON 511	INTERNATIONAL ECONOMICS	1+1	I
AG ECON 512	INSTITUTIONAL ECONOMICS	1+0	II
AG ECON 513	AGRICULTURAL DEVELOPMENT AND POLICIES	2+0	I
AG ECON 514	NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS	1+1	II
AG ECON 515	INTELLECTUAL PROPERTY MANAGEMENT	1+0	I
AG ECON 516/ ❷ COMP 501	COMPUTER PROGRAMMING IN STATISTICAL RESEARCH	2+1	I, II
AG ECON 517	RURAL MARKETING	2+0	I
AG ECON 518	COMMODITY FUTURES TRADING	2+0	II
AG ECON 591	MASTERôS SEMINAR	1	I, II
AG ECON 599	MASTERôS RESEARCH	20	I, II
AG ECON 601**	ADVANCED MICRO-ECONOMIC ANALYSIS	1+1	II
AG ECON 602**	ADVANCED MACRO-ECONOMIC ANALYSIS	2+0	II
AG ECON 603**	ADVANCED ECONOMETRICS	2+1	II
AG ECON 604**	ADVANCED PRODUCTION ECONOMICS	2+1	I
AG ECON 605	QUANTITATIVE DEVELOPMENT POLICY ANALYSIS	1+1	I
AG ECON 606**	ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS	2+1	II
AG ECON 607	FARM ORGANISATION AND MANAGEMENT	1+1	II
AG ECON 608	AGRICULTURAL FINANCE AND CO-OPERATION	2+0	I
AG ECON 609	NATURAL RESOURCE MANAGEMENT	1+1	II
AG ECON 610	ENVIRONMENTAL ECONOMICS	2+1	I
AG ECON 691	DOCTORAL SEMINAR I	1	I, II
AG ECON 692	DOCTORAL SEMINAR II	1	I, II
AG ECON 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSE			
FOR 510	ECONOMICS OF AGROFORESTRY SYSTEMS	2+1	II

* Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

Minor subject both for Masterôs and Doctoral programme: Statistics

To be taught by: ❶ Agricultural Economics; ❷ Computer Section

AGRICULTURAL ECONOMICS

Course Contents

AG ECON 501 MICRO ECONOMIC THEORY AND APPLICATIONS 2+0 SEM - 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 consumerôs 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 ï Income effect and substitution effect ï Applications of Indifference curve approach - Revealed Preference Hypothesis ï Consumer surplus - Derivation of Demand curve ï Elasticity of demand.

UNIT-II: Theory of Production - Production functions ï Returns to scale and economies of scale ï Technical progress ï Theory of Costs ï Cost curvesï Profit maximization and cost minimization ï Derivation of supply curve ï Law of Supply ï Producersô surplus.

UNIT-III: Market Equilibrium - Behavior of Firms in Competitive Markets - Perfect Competition- Monopoly- Monopolistic - Oligopoly- Theory of Factor Markets.

UNIT-IV: General Equilibrium Theory - Welfare Economics - Pareto Optimality ï 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.

AG ECON 502 MACRO ECONOMIC THEORY 2+0 SEM - I

Objective

Macro economic theory 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- Sayôs Law, Modern theory of Employment - 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 its types, different versions of Quantity Theory of Money and Friedmanôs contributions, Keynesian Reformulated Quantity Theory of Money, Inflation: Nature, types, 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.

UNIT-V: Business/Trade cycles ï Its meaning, phases, characteristics and types, Concepts of economic growth models.

Suggested Readings

Ahuja HL. 2007. *Macroeconomics: Theory and Policy*. S. Chand & Co.

Eugene A Diulio 2006. *Macroeconomics*. 4th Ed. Schaumsô Outlines.

Gardner Ackely 1987. *Macro Economic: Theory and Policy*. Collier Macmillan.

Dornbusch. 2006. *Macroeconomics*. McGraw Hill.

AG ECON 503 EVOLUTION OF ECONOMIC THOUGHT 1+0 SEM - II

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 ï Absolutist vs. Relativist approaches ï Evolution of Economic Thought vs. Economic History. Ancient economic thought ï medieval economic thought ï mercantilism ï physiocracy ï Forerunners of Classical Political Economy.

UNIT-II : Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo) ï Critics of Classical Thoughts- Socialist critics ï Socialist and Marxian Economic Ideas ï Austrian School of Thought ï Origins of Formal Microeconomic Analysis ï William Stanley Jevons, Cournot and Dupuit.

UNIT-III: The birth of neoclassical economic thought ï Marshall and Walras ï General Equilibrium Theory - Welfare Theory ï Keynesian economics.

UNIT-IV: The Era of globalization ï Experiences of developing world - Rigidity of the past vs. emerging realism ï The changing path of international Institutions to economic growth and development approaches.

UNIT-V: Economic Thought in India ï Naoroji and Gokhale ï Gandhian Economics - Economic thought of independent India ï Nehruôs economic philosophy - Experiences of the Structural adjustment programmes of the post liberalization era.

Suggested Readings

Blaug M. 1964. *Economic Theory in Retrospect*. Heineman.

Blaug M. 1986. *Economic History and the History of Economic Thought*. Wheatsheaf Books, Brighton.

Ekelund RB & Hebert RF. 1975. *A History of Economic Theory and Methods*. McGraw-Hill.

John Mills A. 2002. *Critical History of Economics: Missed Opportunities*. Palgrave Macmillan.

Screpanti E & Zamagni S. 1995. *An Outline of the History of Economic Thought*. Clarendon Press, Oxford.

AG ECON 504 FARM MANAGEMENT AND AGRICULTURAL PRODUCTION ECONOMICS 2+1 SEM - I

Objective

To expose the students to the basic concepts, significance, uses and application of principles of farm management/agricultural production economics.

Theory

UNIT-I: Review of principles of Farm Management of Principles of Farm Management, Appraisal of Farm Resources and Preparation of Farm Plans, Farm inventory and budgeting. Nature, scope and significance of Farm Management and agricultural production economics- Agricultural Production processes, 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 ï cost and production functions and its applications -Economies and diseconomies of scale. Diversification and crop insurance, Appraisal of farm business income and efficiency measures.

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. Farm adjustment programme under risk and uncertainty.

Practical

Different forms of production functions - specification, estimation and interpretation of production functions ï 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 McGraw Hill.

AG ECON 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 2+1 SEM - I

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 important concepts in Agricultural Marketing - Characteristic of Agricultural product and Production ï 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, Marketing costs and margins, market integration- types of market integration, degree and effects of integration.

UNIT-II: Different Approaches to Study Agricultural Marketing: Functional, Institutional, Commodity, Behavioural System and Legal Economic Approach. Marketing Functions and their different classifications.

UNIT-III: Co-operative Marketing and Regulated Markets, Important Marketing Regulation Acts of different States of India. Features of regulated markets, benefits of regulation, suggestions for improvements in regulated markets- State trading, Warehousing and other Government agencies -Performance and Strategies - Market infrastructure needs, performance and Government role.

UNIT-IV: Role of Information Technology and telecommunication in marketing of agricultural commodities, identifying market opportunities through marketing information systems and research ï market information service-elements of the information system-sources of global information-market research-special problems in international market research..

UNIT-V: Spatial and temporal price relationship ï types of prices- role of prices- price forecasting. Price policy and economic development.

Practical

Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Performance analysis of Regulated market and marketing societies. Market Intelligence ï Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports ï 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.

AG ECON 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 1+1 SEM - II

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 ï research prioritization ï selection of research problem. Approach to research ï research process.

UNIT-II: Hypothesis ï meaning - characteristics - types of hypothesis ï review of literature ï setting of Course Objective and hypotheses - testing of hypothesis.

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

UNIT-IV: Data collection ï assessment of data needs ï sources of data collection ï discussion of different situations. Mailed questionnaire and interview schedule ï structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule ï problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey ï Reconnaissance survey and Pre testing.

UNIT-V: Coding editing ï tabulation ï validation of data. Tools of analysis ï data processing. Interpretation of results ï Preparing research report / thesis ï Universal procedures for preparation of bibliography ï writing of research articles.

Practical

Exercises in problem identification. Project proposals ï contents and scope. Formulation of Objective and hypotheses. Assessment of data needs ï sources of data ï methods of collection of data. Methods of sampling ï criteria to choose ï discussion on sampling under different situations. Scaling Techniques ï 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 ï 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.

AG ECON 507 PRINCIPLES OF ECONOMETRICS 2+1 SEM - I

Objective

The 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: Introduction ï relationship between economic theory, mathematical economics 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 ï identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation ï data problems and remedial approaches - model misspecification.

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

UNIT-V: Simultaneous equation models ï 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 and 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.

Suggested Readings

Gujarati DN. 2003. *Basic Econometrics*. McGraw Hill.

Johnson AG Jr., Johnson MB & Buse RC. 1990. *Econometrics - Basic and Applied.* MacMillan.

Kelejan HH & Oates WE. 1994.*Introduction to Econometrics Principles and Applications*. Harper & Row.

Koutsoyianis A. 1997. *Theory of Econometrics*. Barner & Noble.

Maddala GS. 1992. *Introduction to Econometrics*. MacMillan.

Maddala GS. 1997. *Econometrics.* McGraw Hill.

Pindyck RS & Rubinfeld DL. 1990. *Econometrics Models and Econometric Forecasts*. McGraw Hill.

AG ECON 508 LINEAR PROGRAMMING 1+1 SEM - II

Objective

The objective of this 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, 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

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 Publ.

AG ECON 509 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT 2+1 SEM – II

Objective

The objective of this 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 ï 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 MFIôs - NGOôs, and SHGôs.

UNIT-II: Lending to farmers ï The concept of 3 Côs, 7 Pôs 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 ï credit widening and credit deepening.

UNIT-III: Financial Decisions ï 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 ï Undiscounted measures. Time value of money ï Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques ï PERT and CPM.

UNIT-V: Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes ï 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 - NGOôs and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques ï Undiscounted Measures and their limitations. Project appraisal techniques ï Discounted Measures, Network techniques ï PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies ï crop insurance schemes, Financial instruments and methods ï 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.

AG ECON 510/ SST 514 SEED MARKETING AND MANAGEMENT 2+1 SEM - II

Objective

To train the students regarding economic concepts of seed marketing in India and role of Government in development of efficient seed marketing system.

Theory

UNIT-I: Basic concepts of agricultural marketing, seed marketing, importance and scope of seed industry in India, major constraints/problems in seed industry/seed sector.

UNIT-II: Demand and supply of seed, cost of production and returns and factors determining seed needs, pricing policies: seed pricing and price policies, seed processing and packing/packaging.

UNIT-III: Purpose and approaches to seed marketing; Seed marketing mix, sales promotion, distribution channels, marketing costs and margins. Market research, information and segmentation.

UNIT-IV: Policy environment for sustainable growth of Seed sector in India. Salient features of proposed seed act and national seed policy, role of government in efficient seed marketing: quality control and assurance. WTO and Seed industry in India.

Practical

Estimation of cost of seed production, marketing costs and margins of seeds of different crops. Estimation of seed demand and supply, seed forecasting techniques, marketing plan.

Suggested Readings

Kohls RL & Uhl JN. *Marketing of Agril. Products*. Prentice Hall.

Pingali Venugopal, 2004. *State of Indian Farmer: A Millennium Study*, Vol. VIII: *Input Management*. Academic Foundation, Department of Agriculture, and Cooperation, Ministry of Agriculture, GOI, New Delhi.

AG ECON 511 INTERNATIONAL ECONOMICS 1+1 SEM - I

Objective

The expected outcome of this course will be creating awareness among the students about the role of International Economics on National welfare.

Theory

UNIT-I: Scope and Significance of International Economics - The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) ï Equilibrium in a Simple Open Economy - Possibility of World Trade - Trade gains and Trade Equilibrium.

UNIT-II: Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.

UNIT-III: Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model - Trade Creation and Trade Diversion ï Offer Curve - Export Supply Elasticity and Import Demand Elasticity - Comparative Advantage and Absolute Advantage.

UNIT-IV: Official Exchange Rate and Shadow Exchange Rate - Walraôs Law and Terms of Trade ï Trade Blocks.

UNIT-V: IMF, World Bank, IDA, IFC, ADB ï International Trade agreements ï Uruguay Round ï GATT ï WTO.

Practical

Producer's Surplus, Consumer's Surplus, National Welfare under Autarky and Free Trade Equilibrium with small and large country assumption- Estimation of Trade Gains- Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC- Estimation of Offer Curve Elasticity- Estimation of Effect of Tariff, Export Subsidy, Producer Subsidy, Import Quota and Export Voluntary Restraints on National Welfare- Estimation of Ricardian Model - Estimation of Effect of Trade under Specific Factor Model- Estimation of trade Equilibrium under Heckscher -Ohlin model - Trade Creation and Diversion.

Suggested Readings

Apple Yard DR & Field AJ Jr. 1995. *International Economics - Trade, Theory and Policy*. Irwin, Chicago.

Cherunilam F. 1998. *International Economics*. Tata McGraw Hill.

Krugman PR & Obstfeld M. 2000. *International Economics – Theory and Policy*. Addison-Wesley.

AG ECON 512 INSTITUTIONAL ECONOMICS 1+0 SEM - II

Objective

The course exposes the students to the institutional problems and remedies.

Theory

UNIT-I: Old and New Institutional Economics - Institutional Economics Vs Neo- classical Economics. Definition of institutions ï Distinction between institutions and organizations - Institutional evolution

UNIT-II: Institutional change and economic performance - national and international economic institutions. Transaction cost economics ï Transaction costs and the allocation of resources. Transaction costs and efficiency. Asymmetric information - Moral hazard and Principal-Agent problem.

UNIT-III: Free rider problem ï path dependency ï Interlinked transactions. Collective action and the elimination of free-rider problem - The logic of collective action and its role in reducing free rider problem ï theory of Groups. Rent seeking ï interest groups and policy formulation.

UNIT-IV: Economic analysis of property rights- property rights regimes ï private property ï State Property - Common property Resources (CPRs) ï public goods and club goods.

UNIT-V: Special features of institutional arrangements in agriculture ï Transaction costs in agriculture - Case Studies - Theories of agrarian institutions - tenancy institutions.

Suggested Readings

Barzel Y. 1990. *Economic Analysis of Property Rights*. Cambridge Univ. Press.

Bhardhan P. (Ed.). 1989. *The Economic Theory of Agrarian Institutions*. Clarendon Press, Oxford.

Bromley DW. 1989. *Economic Interests and Institutions: The Conceptual Foundations of Public Policy*. Basil Blackwell, Cambridge.

Eggertsson T. 1990. *Economic Behaviour and Institutions*. Cambridge Univ. Press.

Greif A. 2006. *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade (Political Economy of Institutions & Decisions)*. Univ. Press.

Neelakandan S. 1992. *New Institutional Economics and Agrarian Change – A Primer*. Indian Economic Association Trust for Research and Development, New Delhi.

North DC. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge Univ. Press.

Ostrom E. 1990. *Governing the Commons: The Evolutions of Institutions for Collective Actions.* Cambridge Univ. Press.

AG ECON 513 AGRICULTURAL DEVELOPMENT AND POLICIES 2+0 SEM - I

Objectives

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

Theory

UNIT-I: Development Economics ï Scope and Importance - Economic development and economic growth - divergence in concept and approach - Indicators and Measurement of Economic Development ï GNP as a measure of economic growth ï New Measures of Welfare ï NEW and MEW ï PQLI ï HDI ï Green GNP - Criteria for under development ï Obstacles to economic development ï Economic and Non-Economic factors of economic growth.

UNIT-II: Economic development – meaning, stages of economic development, determinants of economic growth, 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 Model - policy options for sustainable agricultural development.

UNIT-V: Globalization and the relevance of development policy analysis ï The dilemma of free trade? ï Free trade versus Protectionism- Arguments for protection. Arguments against protection. Role of protection in Developing Countries. WTO ï Agreement on Agriculture - Contradictions of free trade - proponents and opponents policies in vulnerable sectors like agriculture ï Lessons for developing countries.

Suggested Readings

Chakaravathi RM. 1986. *Under Development and Choices in Agriculture*. Heritage Publ., New Delhi.

Diwett KK. 2002. *Modern Economic Theory***.** S. Chand & Co.

Eicher KC & Staatz JM. 1998. *International Agricultural Development*. John Hopkins Univ. Press.

Frank E. 1992. *Agricultural Polices in Developing Countries*. Cambridge Univ. Press.

Ghatak S & Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate, New Delhi.

Jhingan ML. 1998. *The Economics of Development and Planning*. Vrinda Publ.

Jules PN. 1995. *Regenerating Agriculture – Policies and Practice for Sustainability and Self Reliance*. Vikas Publ. House.

Naqvi SNH. 2002. *Development Economics – Nature and Significance*. Sage Publ.

AG ECON 514 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS 1+1 SEM- II

Objectives

- To introduce economics principles related to natural resource and environmental economics
- To explore the concept of efficiency and the efficient allocation of natural resources
- To understand the economics of why environmental problems occur.
- To explore the concept of efficiency and the efficient allocation of pollution control and pollution prevention decisions.
- To understand the environmental policy issues and alternative instruments of environmental policies

Theory

UNIT-I: Concepts, Classification and Problems of Natural Resource Economics ï Economy - Environment interaction ï The Material Balance principle, Entropy law- Resources Scarcity - Limits to Growth - Measuring and mitigating natural resource scarcity ï Malthusian and Recardian scarcity ï scarcity indices - Resource Scarcity and Technical Change.

UNIT-II: Theory of optimal extraction renewable resources ï economic models of oil extraction- efficiency - time path of prices and extraction - Hotellingôs rule, Solow-Harwick's Rule. Theory of optimal extraction exhaustible resources ï economic models of forestry and fishery.

UNIT-III: Efficiency and markets ï market failures - externalities ï types - property rights ï transaction costs ï Coase's theorem and its critique - public goods - common property and open access resource management - Collective action.

UNIT-IV: Environmental perspectives - biocentrism, sustainability, anthropocentrism - Environmental problems and quality of environment - Sources and types of pollution -air, water, solid waste, land degradation ï environmental and economic impacts - Economics of pollution control - efficient reduction in environmental pollution.

UNIT-V: Environmental regulation ï economic instruments - pollution charges - Pigovian tax - tradable permits ï indirect instruments - environmental legislations in India.

UNIT-VI: Concept of sustainable development - Economic Perspective - Indicators of sustainability Relation between development and environment stress- Environmental Kuznet's curve Environmental Accounting ï resource accounting methods - International Environmental Issues ï climate change ï likely impacts -mitigation efforts and international treaties.

Practical

Exhaustible resource management ï optimum rate of oil extraction. Renewable resource management ï optimum harvest of Forestry/fishery. Exercise on pollution abatement ï I. Exercise on pollution abatement ï II. Concepts in valuing the environment. Taxonomy of valuation techniques. Productivity change method ï substitute cost method - Hedonic price method - Travel cost method -Contingent valuation methods. Discount rate in natural resource management. Environment impact assessment Visit to Pollution Control Board.

Suggested Readings

Ahmad Y, El Serafy S & Lutz E. (Eds.). 1989.*Environmental Accounting for Sustainable Development*. World Bank.

Freeman AM. 1993. *The Measurement of Environmental and Resource Values*. Resources for the Future Press, Baltimore.

Hackett SC. 2001. *Environmental and Natural Resource Economics: Theory, Policy, and the Sustainable Society*. M. E. Sharpe, Armonk, NY.

Hartwick JM & Olewiler ND. 1998. *The Economics of Natural Resource Use*. 2nd Ed. Addison-Wesley Educational Publ.

Kerr JM, Marothia DK, Katar Singh, Ramasamy C & Bentley WR. 1997. *Natural Resource Economics: Theory and Applications in India.* Oxford & IBH.

Kolstad CD. 2000. *Environmental Economics*. Oxford Univ. Press.

Pearce DW & Turner K. 1990. *Economics of Natural Resources and the Environment*. John Hopkins Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.

Sankar U. 2001. *Environmental Economics*. Oxford Univ. Press.

Sengupta R. 2000. *Ecology and Economy, an Indian Perspective*. Oxford Univ. Press.

Tietenberg T. 2003. *Environmental and Natural Resource Economics*. 6th Ed. Addison Wesley.

AG ECON 515 INTELLECTUAL PROPERTY MANAGEMENT 1+0 SEM - I

Objective

The objective of this course is to create awareness about intellectual property rights in agriculture. The course deals with management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and bio-diversity protection. The students will be taught on the Marketing and Commercialization of Intellectual Properties.

Theory

UNIT-I: World Trade Organization- Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - Importance of Intellectual Property Management - IPR and Economic growth- IPR and Bio diversity -Major areas of concern in Intellectual Property Management -Technology Transfer and Commercialization-Forms of different Intellectual Properties generated by agricultural research.

UNIT-II: Discovery *versus* Invention - Patentability of Biological Inventions - Method of Agriculture and Horticulture- procedure for patent protection: Preparatory work. Record keeping, writing a patent document, filing the patent document -Types of patent application-patent application under the Patent cooperation treaty (PCT).

UNIT-III: Plant genetic resources -Importance and conservation - Sui Generic System - Plant Varieties Protection and Farmers Rights Act- Registration of Extant varieties - Registration and protection of New Varieties / Hybrids / Essentially Derived Varieties - Dispute prevention and settlement -Farmers' Rights.

UNIT-IV: Trademark- Geographical Indications of Goods and Commodities ï Copy rights-Designs ï Biodiversity Protection.

UNIT-V: Procedures for commercialization of technology - Valuation, Costs and Pricing of Technology- Licensing and implementation of Intellectual Properties- Procedures for commercialization ï Exclusive and non exclusive marketing rights-Research Exemption and benefit sharing .

Suggested Readings

Ganguli P. 2001. *Intellectual Property Rights –Unleashing the Knowledge Economy*. Tata McGraw Hill.

Gupta AK. 2003. *Rewarding Conservation of Biological and Genetic Resources and Associated Traditional Knowledge and Contemporary Grass Roots Creativity*. Indian Institute of Management, Ahmedabad.

Khan SA & Mashelkar R. 2004. *Intellectual Property and Competitive Strategies in the 21st Century*. Kluwer Law International, The Hague.

AG ECON 516/ COMP 501 COMPUTER PROGRAMMING IN STATISTICAL RESEARCH **2+1** **SEM - I, II**

(To be taught by Computer Section)

Theory

UNIT I: Introduction to Computers, Types of Computers , Computer generations and classifications , Computer peripherals , Memory units, Control units, Arithmetic and Logic unit, Secondary storage. Computer codes and Arithmetic; Binary system , Octal and Hexadecimal number system, Conversion to decimal system.

UNIT II: Computer softwares ï Machine language , Assembly language , high level language , Compilers , Interpreters and System utilities, Flowcharting and programming , Debugging , testing and Types of errors.

UNIT III: Formulation of Algorithm, Elements of FORTRAN language, constants and variables, Operations and symbols, Expressions, Common mathematical functions.

UNIT IV: Arithmetic assignment statement, Input, Output and FORMAT statements, termination statements, GO TO, Computed GO TO, Arithmetic IF and Logical IF statements, Type statement, Complex and Logical variables, DOUBLE PRECISION variables.

UNIT V: Subscribed variables, Dimension statement, DO statement, Statement function; FUNCTION and SUBROUTINE subprogram, EQUIVALENCE , COMMON and DATA statements.

Practical

Development of computer programs in FORTRAN for the measures of central tendency, measures of dispersion, correlation and regression , simple testing of significance and analysis of CRD and RBD.

Suggested Readings

Rajaraman V. *Computer Programming in FORTRAN.*

Ram Kumar. *Programming in FORTRAN-77.*

Sharma KD. *Programming in FORTRAN.*

AG ECON 517 RURAL MARKETING **2+0** **SEM - I**

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 consumerôs behaviour - behavior of rural consumers and farmers; buyer characteristics and buying behaviour; 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 Course Objective, pricing policy and pricing strategy.

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

Suggested Readings

Krishnamacharyulu CSG & Ramakrishan L. 2002. *Rural Marketing.* Pearson Edu.

Ramaswamy VS & Nanakumari S. 2006. *Marketing Management.* 3rd Ed. MacMillan.

Singh AK & Pandey S. 2005. *Rural Marketing*. New Age.

Singh Sukhpal. 2004. *Rural Marketing*. Vikas Publ. House.

AG ECON 518 COMMODITY FUTURES TRADING **2+0** **SEM - II**

Objective

This course is aimed at providing the basic understanding and the mechanics and value of futures markets for speculators and hedgers who in turn will serve as price risk management activities of agribusiness firms.

Theory

UNIT-I: History and Evolution of commodity markets ï Terms and concepts: spot, forward and futures Markets ï factors influencing spot and future markets. Speculatory mechanism in commodity futures.

UNIT-II: Transaction and settlement ï delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.

UNIT-III: Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features.

UNIT-IV: Important global and Indian commodity exchanges - contracts traded ï special features -Regulation of Indian commodity exchanges - FMC and its role.

UNIT-V: Fundamental Vs Technical analysis ï construction and interpretation of charts and chart patterns for analyzing the market trend ï Market indicators ï back testing. Introduction to technical analysis software ï analyzing trading pattern of different commodity groups.

Suggested Readings

Kaufman PJ. 1986. *The Concise Handbook of Futures Markets*. John Wiley & Sons.

Leuthold RM, Junkus JC & Cordier JE. 1989. *The Theory and Practice of Futures Markets.* Lexington Books.

Lofton T. 1993. *Getting Started in Futures*. 3rd Ed. John Wiley & Sons.

Purcell WD. 1991. *Agricultural Futures and Options: Principles and Strategies*. Macmillan Publ.

Wasendorf RR & McCafferty 1993. *All about Commodities from the Inside Out.* McGraw-Hill.

AG ECON 601 ADVANCED MICRO-ECONOMIC ANALYSIS 1+1 SEM - II

Objective

The objective of this course is to introduce the theoretical models and applications of microeconomic theory. In particular, the basic comparative statistical techniques and the more modern duality theory will be developed and applied to the models of maximization, unconstrained and constrained utility maximization, expenditure minimization, constrained profit maximization, and cost and expenditure minimization. These mathematical structures form the basic building blocks of neoclassical economics; this course will stress the development and application of these important models. We follow a calculus rather than a graphical approach to the theory. In the subsequent sections of the course, we provide a fairly rigorous exposure to price determination under different market situations, general equilibrium theory, causes and consequences of market failure and welfare economics including the theory of public choice.

Theory

UNIT-I: Theory of consumer behaviour ï Duality in consumer theory - expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumersô Welfare ï Consumerôs Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions ï Integrability of demand functions. Demand Models ï Linear Expenditure System, Almost Ideal Demand System. Applications of consumer theory ï Household model and time allocation ï Labour supply decisions by households.

UNIT-II : Perfect competition ï Monopoly, monopolistic competition and oligopoly. Oligopoly models ï collusive and non-collusive models of oligopoly - Cournot model, Chamberlin model, Stackleberg solution.

UNIT-III: General equilibrium theory ï Conceptual overview - General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium ï Mathematical derivation of conditions for general equilibrium.

UNIT-IV: Market failure - Incomplete markets - Asymmetric information ï Principal-Agent problem, adverse selection and moral hazard. Externalities ï Network externalities - Public goods ï Optimal provision of public goods.

UNIT-V: Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare ï Criteria for social welfare - Social Welfare functions, Social versus Private costs and benefits.

Practical

Problems in consumer utility maximization ï Estimation of income and substitution effects; Estimation and comparison of Consumerôs surplus, equivalent variation and compensating variation. Estimation of demand models ï Derivation and estimation of labour supply equations from household models comparative static analysis in consumption. Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition. Game theory models. Problems solving in General Equilibrium Theory and Welfare Economics. Problems in public goods provision.

Suggested Readings

Chiang AC. 1981. *Fundamental Methods of Mathematical Economics*. McGraw-Hill.

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

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

Kreps DM. 1990. *A Course in Microeconomic Theory*. Princeton Univ. Press.

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

Varian HR. 1992. *Microeconomic Analysis*. WW Norton & Co.

Varian HR. 1999. *Intermediate Microeconomics*. Affiliated East-West Press.

AG ECON 602 ADVANCED MACRO-ECONOMIC ANALYSIS 2+0 SEM - II

Objectives

Advanced macroeconomics course will be offered to Ph.D. students of Agricultural Economics with the following Course Objective

- to understand the macroeconomic theory
- to examine the macroeconomic Policy issues
- to analyze the macroeconomic Policy implications.

Theory

UNIT-I: Review of Macro Economics concepts-Comparative statistics- Keynesian theory-Consumption Function and Theories of Consumption -Saving Function and Theories of Saving.

UNIT-II: Theories of Investment-Savings and Investment Equality - IS - LM Framework and its demand for and Supply of Money-Monetary Policy in the static model ï Inflation.

UNIT-III: Stagflation and Supply side Economics - Theory of Unemployment - Phillips Curve controversy ï Inflation and deflation, inflationary gap, effects and importance of inflation and deflation, types, measures to control, Productivity and distribution - Fiscal policy: Effectiveness and Problems.

UNIT-IV: National Income and Social Accounting- Different concepts of national income, methods of measurement of national income, problems in estimation of national income, Neo classical Macro Economics - Stochastic Macro Economics.

UNIT-V: Review of Economic Growth Models-The Harrod-Domar Model, The Kaldor Model, Joan Robinson Model, Ricardian Model etc. Review of Macro Economic Policies in India.

Suggested Readings

Diulio EA. 2006. *Macroeconomics*. 4th Ed. Schaumsô Outlines.

Frogen RT. 1999. *Macro Economic: Theory and Policies*. 6th Ed. Prentice Hall.

Samuelson PA & Nordhaus WD. 2004. *Economics*. McGraw-Hill.

Shapiro E. 1989. *Macro Economic Analysis*. Galgotia Publ.

AG ECON 603 ADVANCED ECONOMETRICS 2+1 SEM - II

Objective

The objective of this course is to impart knowledge on advanced econometric tools to the Research Scholars of agricultural economics. Training in advanced econometrics will help the Research Scholars to analyse the economic problem by applying quantitative techniques.

Theory

UNIT-I: Review of classical regression model ï review of hypothesis testing ï restrictions on parameters ï single equation techniques.

UNIT-II: Ordinary least squares ï weighted least squares - generalized least squares ï method of principal components ï instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests ï non spherical error terms.

UNIT-III: Dummy variables - Qualitative and truncated dependent variables - limited dependent variables ï LPM, probit and logit models, their multinomial extensions.

UNIT-IV: Autoregressive distributed lag models ï panel data fixed and random effects models and their extensions.

UNIT-V: Simultaneous equation methods ï identification ï estimation by indirect least squares 2SLS, SURE, 3SLS.

Practical

Estimation of multiple regression model - GLS estimation methods - testing misspecification errors ï Testing and Managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, Logit and Probit models - comparing two regressions - Chow test - estimation of distributed lag models ï panel data random and fixed effects models - Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models

Suggested Readings

Greene WH. 2002. *Econometric Analysis*. Pearson Edu.

Johnston J & Dinardo J. 2000. *Econometric Methods*. McGraw-Hill.

Kelejan HH & Oates WE. 2001. *Introduction to Econometrics Principles and Applications*. Harper & Row.

Maddala GS. 2002. *Econometrics.* McGraw Hill.

AG ECON 604 ADVANCED PRODUCTION ECONOMICS 2+1 SEM - I

Objective

To expose the students to the concept, significance and uses of advance production economics.

Theory

UNIT-I: Agricultural Production process ï Relationship between farm planning and production economics-scope of agricultural production and planning- methods/procedures in agro-economic research and planning.

UNIT-II: Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance ï Production relations ï optimality-Commonly used functional forms, nature, properties, limitations, estimation and interpretation -linear, Spillman -Cobb Douglas, quadratic, multiplicative (power) functional forms - Translog, and transcendental functional forms -CES, production functional forms-Conceptual and empirical issues in specification, estimation and application of production functions-Analytical approaches to economic optimum - Economic optimum ï determination of economic optimum with constant and varying input and output prices- Economic optimum with production function analysis - input use behaviour.

UNIT-III: Decision making with multiple inputs and outputs ï MRT and product relationship-cost of production and adjustment in output prices-single input and multiple product decisions- Multi input, and multi product production decisions - Decision making with no risk -Cost of wrong decisions - Cost curves ï Principles and importance of duality theory - Correspondence of production, cost, and profit functions - Principles and derivation of demand and supply functions .

UNIT-IV: Technology, input use and factor shares -effect of technology on input use-decomposition analysis-factor shares-estimation methods- Economic efficiency in agricultural production ï technical, allocative and economic efficiency ï measurement - Yield gaps analysis ï concepts and measurement - Risk and uncertainty in agriculture ï incorporation of risk and uncertainty in decision making ï risk and uncertainty and input use level-risk programming.

UNIT-V: Simulation and programming techniques in agricultural production-Multiple Course Objective Programming ï Goal programming and Compromise programming ï applications.

Practical

Estimation of different forms of production functions- Optimal input and product choice from estimated functions-Derivation of demand and supply functions and estimation-Estimation of cost function and interpretations-Optimal product and input choice under multi input and output system-Estimation of factor shares from empirical functions estimated-Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology-Estimation of efficiency measures ï Stochastic, probabilistic and deterministic frontier production functions-Risk programming ï MOTAD-Quadratic programming-Simulation models for agricultural production decisions-Goal programming ï Weighted, lexicographic and fuzzy goal programming-Compromise programming.

Suggested Readings

Chambers RG. 1988. *Applied Production Analysis*. Cambridge Univ. Press.

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

Palanisami KP, Paramasivam & Ranganathan CR. 2002. *Agricultural Production Economics: Analytical Methods and Applications*. Associated Publishing Co.

AG ECON 605 QUANTITATIVE DEVELOPMENT POLICY ANALYSIS 1+1 SEM - I

Objectives

- The course trains the scholars in the art of informed decision making and helps them to appreciate the value of the analytical basis in policy decisions.
- They are given hands on training on the estimation and use of various criteria such as elasticities in making QDPA more meaningful
- The scholars make extensive reviews to get acquainted with the analytical relevance and in drawing inferences.

Theory

UNIT-I: Policy framework ï goals, value, beliefs and welfare maximization. Market ï Policy and State ï State vs. Market ï Failure of Policy ï Failure of Markets - Rationale for Government Intervention. Role of Quantitative Policy Analysis.

UNIT-II: Demand analysis for policymaking ï Alternative approaches to demand analysis ï Policy implications. Supply response ï Alternative approaches to measurement of supply response ï Nerlovian models of supply response ï Policy implications.

UNIT-III: Household behaviour and policy analysis ï Household models.

UNIT-IV: Partial equilibrium analysis ï Concept of reference prices ï Price distortions ï indicators and impact. Transaction costs ï Implications for efficiency and productivity ï Institutional solutions - Multi market approach to policy analysis.

UNIT-V :Social Accounting Matrices and multipliers -ï Computable General Equilibrium models to assess economy wide impact of policy changes.

Practical

Review of criteria for policy evaluation ï Estimation of price elasticities ï Review of estimation of complete demand systems ï Estimation of Nerlovian supply Response model ï Review of Household models ï Specification and estimation of household models ï Partial equilibrium analysis ï Inputï output table ï Social Accounting Matrix ï Construction of a SAM ï computation of Multipliers ï Multi Market Analysis ï Review of Computable General Equilibrium Models.

Suggested Readings

Chenery H & Srinivasan TN. (Eds.). 1988. *Hand book of Development Economics*. North-Holland.

Eicher KC & Staatz JM. 1998. *International Agricultural Development*. Johns Hopkins Univ. Press.

Fischer G, Miller J & Sidney MS. (Eds.). 2007. *Handbook of Public Policy Analysis: Theory, Politics and Methods*. CRC Press.

Frank E. 1992. *Agricultural Policies in Developing Countries*. Cambridge Univ. Press.

Ghatak S & Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate.

Kindleberger PC. 1977. *Economic Development*. McGraw Hill.

Meier MG & Stigilitz JE. 2001. *Frontiers of Development Economics- the Future Perspective.* Oxford Univ. Press.

Sadoulet E & de Janvry A. 1995. *Quantitative Development Policy Analysis*. (London: John Hopkins Univ. Press.
Shoven Neck R, Christian R & Mooslechner P. (Eds.). 2008. *Quantitative Economic Policy Essays in Honour of Andrew Hughes Hallett.*

AG ECON 606 ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS 2+1 SEM - II

Objective

The main objective of this course is to critically analyze the important marketing concepts, models, properties of agricultural commodity prices and forecasting, data collection and analysis using current software etc., in order to make them policy decisions in the field of agricultural marketing.

Theory

UNIT-I: Importance of agricultural Marketing in economic development, classification/ types of markets, components and dimensions of a market - characteristics and role of agricultural prices - data sources for agricultural products and prices.

UNIT-II: Role of various formal institutions in agricultural marketing - and functions - measuring their efficiency - public - private partnership - institutional arrangements. Successful case studies.

UNIT-III: Marketing liberalization; Economic Structural Adjustment Programmes, Macro Economic Stabilization, Strategies for Reforming Agricultural Marketing Parastatals, Obstacles to overcome in Commercialization and privatization of agricultural marketing parastatals.

UNIT-IV: Marketing Strategies, Planning and Control: Corporate Planning, business policy and marketing planning; Process of Strategic marketing planning, Content of a marketing plan; Different types of marketing controls; monitoring & evaluating the marketing plan and optimization of resources; principal techniques used in identifying weaknesses in the performance of the marketing plan.

UNIT-V: Time series analysis for prices and arrivals for agricultural commodities - forecast evaluation; methods of forecasting, price indices, Estimation of price elasticities, pricing decisions and strategies, break even analysis.

Practical

Estimation of demand/ supply forecasting, supply chain / value chain analysis for different commodities, time series analysis - market integration studies- price discovery price volatility estimation - commodity price forecasting. Determination of administered prices through alternative methods.

Suggested Readings

Crawford IM. 1997. *Agricultural and Food Marketing Management,* FAO.
Carter S. 1997. *Global Agril.Marketing Management*. FAO.
Ferris JN. 1998. *Agricultural Prices and Commodity Market Analysis*. McGraw-Hill.
Goodwin JW. 1994. *Agricultural Price Analysis and Forecasting*. Wiley.
Hallam D. 1990. *Econometric Modeling of Agricultural Commodity Markets*. New Routledge.
Martimort D. (Ed.). 1996. *Agricultural Markets: Mechanisms, Failures, and Regulations*. Elsevier.
Schrimper RA. 2001. *Economics of Agricultural Markets*. Pearson.
Timmer CP. 1986. *Getting Prices Right.* Cornell University Press.
Tomek WG & Robinson KL. 2003. *Agricultural Product Prices*. 4th Ed. Cornell University Press.

AG ECON 607 FARM ORGANISATION AND MANAGEMENT 1+1 SEM - II

Objective

To acquaint and impart the training to the students regarding the organization, management and planning of farm and applications of farm management principles and techniques.

Theory

UNIT-I: Management and planning of farm as a unit : Farm Management Vs Management of farm, farm decisions, farm management problems in India, farm resource management, types and systems of farming, factors determining the types of farming**.**

UNIT-II: Application of farm management, Farm finance and Production economic principles: Laws of production or Diminishing Returns, Cost principle, principle of factor substitution, principle of product substitution, principle of equimarginal returns, principle of time comparison, principle of marginalism, principle of comparative advantage, opportunity cost principle, 3-Rôs of credit, principle of ownerôs equity & increasing risk, Five Côs and Seven Pôs**.**

UNIT-III: Farm organization and planning under risk and uncertainty conditions: Risk & uncertainty: A contrast, sources of risk, measures to manage farm risk, management & planning of farm to mitigate the farm risk, decision and game theories & their application in Agriculture. **.**

UNIT-IV: Tools of Farm Management Analysis: Farm Planning, Production Function analysis, Farm records & accounts, depreciation, farm efficiency measures, budgeting and linear programming**.**

UNIT-V: Identification and Management of natural resources: Identification & management of natural resources. Factors responsible for deteriorating natural resources, measures to improve efficient use of natural resources & other farm inputs.

Practical

Application of Farm Management Principles and Production. Function; Determination of optimum farm programme under varying sets of constraints including weather and price risks.

Suggested Readings

Johl SS & Kapoor TR. *Fundamentals of Farm Business Management*. Kalyani Publ.

Kahlon AS & Karam Singh. *Economics of Farm Management in India*: *Theory & Practices*. Allied Publ.

Palanisami K, Paramesivam P & Ranganathan C.R. *Agricultural Production Economics-Analytical Methods and Applications*. Associated Publ. Co., New Delhi.

Raju VT & Rao DVS. *Economics of Farm Production and Management*. Oxford & IBH.

Robertson C.A. *An Introduction to Agricultural Economics and Farm Management*. Tata McGraw-Hill.

Sankhayan PL. *Introduction to Farm Management*. Tata McGraw-Hill.

Subba Reddy S. et al. *Agricultural Economics*. Oxford & IBH.

AG ECON 608 AGRICULTURAL FINANCE AND CO-OPERATION 2+0 SEM - I

Objective

The objective of this course is to impart knowledge on issues related to agricultural credit requirements, principles of agricultural finance and financial management and recent innovations in agricultural credit. The course would also expose students to the principles and practices of co-operation, revitalization of cooperative management and role of cooperatives new economic policy.

Theory

UNIT-I: Role of credit in agricultural and rural development. Estimates of agricultural credit requirements - investment, production, marketing and consumption. Role of public and private sector banks, and co-operatives in development financing. Classification of agricultural credit. Rural credit structure.

UNIT-II: Principles of agricultural finance and financial management. Agricultural Finance as a part of public finance. Agricultural taxation and subsidies, capital in agriculture and sources of capital. Credit and savings - legal aspects of credit. Credit adjustments. Farm planning as a basis for extension of agricultural credit.

UNIT-III: Recent innovations in extension of credit to agriculture. Rural credit supply and credit gap. Multi agency approach and coordination of credit structure at different levels. Agricultural Credit policy. Principles and practices of cooperation. Successes and failures of co-operative sector in India.

UNIT-IV: Credit and non-credit institutions. National Federation of Co-operative Organisations. Review of reforms in co-operative structure. Single window approach in agricultural input supply and output marketing.

UNIT-V: Management of cooperative institutions. Professionalization of co-operatives. Revitalization of co-operative management. Role of co-operatives under new economic policy.

Suggested Readings

Johl SS & Kapoor TR. *Fundamentals of Farm Business Management*. Kalyani Publ.

Kahlon AS & Karam Singh. *Economics of Farm Management-Theory & Practice*. Allied Publ.

Kapila R & Kapila U (Eds.). *Economic Development in India* (Various issues). Academic Foundation.

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

Narayanaswamy R. *Financial Accounting-A Managerial Perspective*. Prentice-Hall of India.

Narendra Jadhav. *Monetary Policy, Financial Stability and Central Banking in India*. Macmillan India.

Pandey IM. *Financial Management*. Vikas Publ.

Subha Reddy S. & Raghu Ram P. *Agricultural Finance and Management*. Oxford & IBH.

Vaish MC. *Money Banking and International Trade*. Vikas Publ.

Wadar LK & Murthy C. *Agricultural Marketing and Cooperation*. ICAR.

Warren F. Lee, Michael D Boehlje, A.G. Nelson & W.G. Murray. *Agricultural Finance*. Kalyani Publ.

William G Murray. *Farm Appraisal and Valuation.* The IOWA State University Press, IOWA.

AG ECON 609 NATURAL RESOURCE MANAGEMENT 1+1 SEM - II

Objective

This is an applied economics course that focuses on the economic analysis of natural resources, and seeks to identify and solve natural resource management problems via mathematical approach using dynamic optimization techniques. During the course, we will encounter bio-economic models of natural resources including the classic and more recent forestry and fisheries models, models of land and water use and extraction of non-renewable resources (such as from a mineral deposit). We will focus on intuition and understanding of the economic analysis rather than complicated mathematical models in this class. That said, natural resource problems are inherently dynamic, so some mathematical modeling of biophysical and economic processes will be required. Using computers as an aid to understanding the models will be an important part of the class. The primary tool will be Microsoft Excel, which is the easiest introduction to computational optimization and graphical representation of the results.

Theory

UNIT-I: Natural resources - definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources. Fundamental equation of renewable resources.

UNIT-II: Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use ï Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.

UNIT-III: Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery.

UNIT-IV: Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources ï Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.

UNIT-V: Resource scarcity ï Natural resource degradation ï Poverty and resource degradation ï Natural resource accounting - Pricing and valuation of natural resources ï Natural resources policy.

Practical

Derivation of the fundamental equation of renewable resources-Estimation of growth curves and stock dynamics for fishery and forestry resources. Simple two period problem of optimal resource use ï Numerical solution for simple two-period model of dynamic efficiency in natural resource extraction. Multi-period dynamic efficiency ï Using Excel Solver in solving dynamic natural resource harvesting problems. Using analytical solution procedures for solving natural resource management problems ï Optimal control.

Suggested Readings

Baland JM & Platteau JP. 1996. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Clarendon Press and FAO.

Carlson GA, Miranowski J & Zilberman D. 1998. *Agricultural and Environmental Resource Economics*. Oxford Univ. Press.

Chiang AC. 1992. *Elements of Dynamic Optimization*. Waveland Press.

Clark CW. 1976. *Mathematical Bioeconomics: The Optimal Management of Renewable Resources*. John Wiley & Sons.

Conrad JM & Clark CW. 1997. *Natural Resource Economics: Notes and Problems*. Cambridge Univ. Press.

Conrad JM. 1999. *Resource Economics*. Cambridge Univ. Press.

Fisher AC. 1981. *Resource and Environmental Economics*. Cambridge Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.

Sterner T. 2003. *Policy Instruments for Environmental and Natural Resource Management*. Resources for the Future, Washington DC.

AG ECON 610 ENVIRONMENTAL ECONOMICS 2+1 SEM - I

Objective

The main objective of this course is to provide an advanced treatment of the economic theory of environmental management and policy, externalities and market and non-market approaches to environmental improvement. Topics in economic growth and environmental problems, poverty and environmental degradation, conservation and sustainable economic growth, intergenerational and global environmental problems, policy issues in environmental regulation and management will be covered at a sufficient depth so as to equip the students with the recent developments in the field.

Theory

UNIT-I: Environmental pollution as a consequence of market failure - Causes and consequences of market failure - Externalities - Public goods and externalities - Economics of pollution ï Private vs. Social cost of environmental pollution ï Property rights, environment and development ï Theory of environmental policy.

UNIT-II: Environmental cost benefit analysis - Environmental impact assessment techniques - Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.

UNIT-III: Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts - Population and environmental quality - poverty and environmental degradation ï Sustainable development ï Indicators of sustainable development ï Issues in sustainable development.

UNIT-IV: Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution - Coastal externalities - Urbanization and environment - Basic approaches to environmental policy (Tax, subsidy, pollution permits etc.) Green taxes - Political economy of environmental regulation and management.

UNIT-V: Transboundary environmental problems - Economics of global warming, climate change and emission trading - Environment, international trade and development.

Practical

Contemporary global environmental global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms - Criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques - Recreation demand models of environmental valuation - Contingent valuation techniques - Environmental Resource Accounting Techniques - Discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts - forest environment and wild life conservation - Green GDP and Green house insurance - Practical considerations and comparison of instruments of environmental policy - Non-point source pollution control methodologies - Environment in macroeconomic modeling - Meta-analysis, economic valuation and environmental economics - Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment - Input output analysis, technology and the environment - Computable general equilibrium models for environmental economics and policy analysis.

Suggested Readings

Carlson GA, Miranowski J & Zilberman D. 1998. *Agricultural and Environmental Resource Economics*. Oxford Univ. Press.

Hanley N, Shogren J & White B. 2007. *Environmental Economics in Theory and Practice*. Palgrave, London.

Kolstad C. 1999. *Environmental Economics*. Oxford Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.

Sterner T. 2003. *Policy Instruments for Environmental and Natural Resource Management. Resources for the Future*. The World Bank and SIDA.

AGRICULTURAL ECONOMICS

List of Journals

- Agricultural Economics Research Review
- Agricultural Finance Review
- Agricultural Marketing
- Agricultural Situation in India
- Agriculture and Agro-industries Journal
- Agriculture Statistics at a Glance
- APEDA Trade yearbook
- Asian Economic and Social Review (Old Series)
- Bulletin of Agricultural Prices
- Economic and Political Weekly
- Economic Survey of Asia and Far East
- FAO Commodity Review and Outlook
- FAO Production Year book
- FAO Trade year book
- Indian Cooperative Review
- Indian Economic Journal
- Indian Journal of Agricultural Economics
- Indian Journal of Agricultural Marketing
- Indian Journal of Economics
- International Food Policy Research Institute Research Report
- Journal of Agricultural Development and Policy
- Journal of Agricultural Economics
- Journal of Agricultural Economics and Development
- Journal of Farm Economics
- Land Economics
- Productivity
- Reserve Bank of India Bulletin
- Rural Economics and Management
- World Agricultural Economics and Rural Sociology Abstracts
- World Agricultural Production and Trade: Statistical Report
- Yojana

e- Resources

- www.pearsoned.com (Pearson Education Publication)
- www.mcgraw-hill.com (McGraw-Hill Publishing Company)
- www.oup.com (Oxford University Press)
- www.emeraldinsight.com (Emerald Group Publishing)
- www.sagepub.com (Sage Publications)
- www.isaeindia.org (Indian Society of Agriculural Economics)
- www.macmillanindia.com (Macmillan Publishing)
- www.icar.org.in (Indian Council of Agricultural Research)
- www.khoj.com (Directory for Agricultural Economics)
- www.ncap.res.in (National Centre for Agricultural Economics and Policy Research)
- www.ncdex.com (National Commodity & Derivatives Exchange Limited)
- www.phdcci.in (PHD Chamber of Commerce and Industry)
- www.ficci.com (Federation of Indian Chambers of Commerce and Industry)
- www.assocham.org (Associated Chambers of Commerce and Industry of India)
- www.apeda.com (Agricultural and Processed Food Products Export Development Authority)
- www.mpeda.com (Marine Products Export Development Authority)

Suggested Broad Topics for Master's and Doctoral Research

- Economics of irrigation water in different agro-climatic conditions
- Potential of exports of agri-products
- Potential domestic as well as international markets for value added agri-products
- Demand and supply gap of different agri-products and agri-inputs
- Economic analysis of new agri-technologies
- Input use efficiency in different agro-climatic conditions
- Income and expenditure pattern in rural areas
- Saving and investment pattern in rural areas
- Return from investment in agriculture research
- Marketing of agri-products in WTO regime
- Impact of WTO on agricultural economy
- Impact of agricultural credit on socio-economic condition of the farmers
- Optimization of production process to reduce the cost of production
- Economic analysis of diversification, processing and value addition in agriculture sector
- Emerging international marketing scenario of agri-products
- Extent of farmersô indebtedness in different agro-climatic conditions

AGRICULTURAL METEOROLOGY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
AGM 501*	FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY	2+1	I
AGM 502*/ ❶ AGRON 505	FUNDAMENTALS OF AGRICULTURAL METEOROLOGY	2+1	I
AGM.503*	MICROMETEOROLOGY	2+1	II
AGM 504*	AGRO-METEOROLOGICAL INSTRUMENTATION AND MEASUREMENTS	1+2	I
AGM 505	SOIL WATER BALANCE CLIMATOLOGY	2+1	II
AGM 506/ ❷ AGRON 603	CROP PRODUCTION AND SYSTEM MODELING	1+2	II
AGM 507/ ❶ FSC 513	WEATHER MODIFICATION AND RISK MANAGEMENT STRATEGIES	2+0	I
AGM 508	PRINCIPLES OF REMOTE SENSING AND ITS APPLICATIONS IN AGRICULTURE	2+1	II
AGM 509	APPLIED AGRICULTURAL CLIMATOLOGY	1+2	I
AGM 591	MASTERôS SEMINAR	1	I, II
AGM 599	MASTERôS RESEARCH	20	I, II
AGM 601	CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT	2+1	I
AGM 602	WEATHER FORECASTING	2+1	II
AGM 603	AIR POLLUTION METEOROLOGY	2+1	I
AGM 604	WEATHER, CLIMATE AND LIVESTOCK	2+1	II
AGM 605	ANALYTICAL TOOLS AND METHODS FOR AGRO-METEOROLOGY	2+1	I
AGM 606	STRATEGIC USE OF CLIMATIC INFORMATION	2+1	II
AGM 607/ ❸ STAT 511	STATISTICAL METHODS FOR APPLIED SCIENCES	3+1	I, II
AGM 608	DATABASE MANAGEMENT AND COMMERCIALIZATION OF AGROMETEOROLOGICAL DATA IN E-SERVICES	1+2	II
AGM 691	DOCTORAL SEMINAR I	1	I, II
AGM 692	DOCTORAL SEMINAR II	1	I, II
AGM 699	DOCTORAL RESEARCH	45	I, II

* Compulsory for Masterôs programme

To be taught by: ❶ Agricultural Meteorology; ❷ Agricultural Meteorology and Agronomy; ❸ Statistics

AGM 501 FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY 2+1 SEM - I

Objective

To impart theoretical and practical knowledge of physical processes occurring in atmosphere and techniques used in meteorology.

Theory

UNIT-I: Solar radiation and laws of radiation; greenhouse effect, albedo, and heat balance of the earth and atmosphere; variation of pressure and temperature with height, potential temperature, pressure gradient, cyclonic and anticyclonic motions; geostropic and gradient winds; equations of motion; general circulation, turbulence, vorticity, atmospheric waves.

UNIT-II: Gas laws, laws of thermodynamics and their application to atmosphere; water vapour in the atmosphere, various humidity parameters and their interrelationships; vapour pressure, psychrometric equation, hydrostatic equation, saturation deficit, stability and instability conditions in the atmosphere.

UNIT-III: Lapse rates-ascent of dry and moist air, condensation; clouds and their classification; evaporation and rainfall; the hydrological cycle; precipitation processes, artificial rainmaking, thunderstorms and dust storm; haze, mist, fog, and dew; air masses and fronts; tropical and extra-tropical cyclones.

UNIT-IV: Effect of earth's rotation on zonal distribution of radiation, rainfall, temperature, and wind; the trade winds, equatorial trough and its movement; the SE Asia monsoon, El Nino, La Nina and ENSO.

UNIT-V: Measures of central tendency and dispersion, correlation, regression, moving average probability and their distribution function; synoptic, numerical, graphical, spatial analysis of weather systems and charts technique, thermal and comfort indices.

Practical

- Agromet observatory- different classes of observatories (A, B, C)
- Measurements and calculations of weather parameters.
- Weather chart preparation and identification of pressure systems
- Statistical technique for computation of normals, moving average, Markov chain model etc.

Suggested Readings

Barry RG & Richard JC. 2003. *Atmosphere, Weather and Climate*. Tailor & Fransics.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Ghadekar SR. 2001. *Meteorology.* Agromet Publ.

Mcllveen R. 1992. *Fundamentals of Weather and Climate*. Chapman & Hall.

Petterson S. 1958. *Introduction to Meteorology*. McGraw Hill.

Trewartha Glenn T. 1954. *An Introduction to Climate*. McGraw Hill.

AGM 502/ AGRON 505 FUNDAMENTALS OF AGRICULTURAL METEOROLOGY 2+1 SEM - I

Objective

To impart the theoretical and practical knowledge of physical processes occurring in relation to plant and atmosphere with advanced techniques.

Theory

UNIT-I: Meaning and scope of agricultural meteorology; components of agricultural meteorology; role and responsibilities of agricultural meteorologists.

UNIT-II: Importance of meteorological parameters in agriculture; efficiency of solar energy conversion into dry matter production; meteorological factors in photosynthesis, respiration and net assimilation; basic principles of water balance in ecosystems; soil-water balance models and water production functions.

UNIT-III: Crop weather calendars; weather forecasts for agriculture at short, medium and long range levels; agromet advisories, preparation, dissemination and economic impact analysis; introduction to GIS, GPS and remote sensing; use of satellite imageries and synoptic charts in weather forecasting; meteorological aspects of forest fires and their control

UNIT-IV: Concept, definition, types of drought and their causes; prediction of drought; crop water stress index, crop stress detection; air pollution and its influence on vegetation.

UNIT-V: Concepts of mechanistic and deterministic models; general features of dynamical and statistical modeling techniques; weather data and phenology-based approaches to crop modeling; validation and testing of models.

UNIT-VI: Climatic change, green house effect, CO2 increase, global warming and their impact on agriculture; climate classification, agro-climatic zones and agro-ecological regions of India and Haryana.

Practical

- Preparation of crop weather calendars
- Development of simple regression models for weather, pest and disease relationship in different crops.
- Working with dynamic and simulation models.
- Preparation of weather based agro-advisories.

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Critchfield HJ. 1995. *General Climatology*, Prentice Hall of India.

Kakde JR. 1985. *Agricultural Climatology*. Metropolitan Book Co.

Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principle and Application of climate Studies in Agriculture*. Haworth Press.

Variraju R & Krishnamurthy. 1995. *Practical Manual on Agricultural Meteorology.* Kalyani Publ.

Varshneya MC & Pillai PB. 2003. *Text Book of Agricultural Meteorology*. ICAR.

AGM 503 MICROMETEOROLOGY 2+1 SEM - II

Objective

To impart the theoretical and practical knowledge of physical processes occurring in lower atmosphere.

Theory

UNIT-I: Properties of atmosphere near the earth's surface; exchange of mass, momentum and energy between surface and overlaying atmosphere, exchange coefficients, similarity hypothesis, shearing stress, forced and free convection**.**

UNIT-II: Molecular and eddy transport of heat, water vapour and momentum, frictional effects, eddy diffusion, mixing length; temperature instability; microclimate near the bare ground, unstable and inversion layers, soil moisture and temperature variation with depth; Richardson number, Reynoldôs analogy.

UNIT-III: Micrometeorology of plant canopies; distribution of temperature, humidity, vapour pressure, wind and carbon dioxide; modification of microclimate due to cultural practices, intercropping; radiation distribution and utilization by plant communities, leaf temperature and its biological effects; concepts of evapotranspiration and its estimation approaches.

UNIT-IV: Influence of topography on microclimate; shelter belts and wind breaks, microclimate in crop fields, forests, glass and plastic houses.

Practical

- Micrometerological measurements in crop canopies
- Determination of ET by different methods

Suggested Readings

Arya S Pal. 1988. *Introduction to Micrometeorology.* Academic Press.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Gates DM. 1968. *Energy Exchange in the Biosphere.* UNESCO.

Goudriaan J. 1983. *Crop Micrometeorology: A Simulation Study*. Scientific Publ.

Grace J. 1983. *Plant Atmospheric Relationships: Outline Studies in Ecology*. Chapman & Hall.

Gupta PL & Rao VUM. 2000. *Practical Manual on Micrometeorology*. Dept. of Agril. Meteorology, CCS HAU Hisar, India.

Jones HG. 1992. *Plants and Microclimate*. Cambridge Univ. Press.

Munn RE. 1970. *Biometeorological Methods*. Academic Press.

Rosenberg NJ. 1974. *Microclimate – The biological Environment*. John Wiley & Sons.

Sellers W. 1967. *Physical Climatology*. The University of Chicago Press.

AGM 504 AGRO-METEOROLOGICAL INSTRUMENTATION AND MEASUREMENTS 1+2 SEM - II

Objective

To impart the theoretical and practical knowledge of instruments/equipments used for measurement of agro-meteorological variables.

Theory

UNIT-I: Fundamentals of measurement techniques; exposure and operation of meteorological instruments/ equipments in agromet observatories; theory and working principles of barometers, thermometers, psychrometers, hygrometer and thermo-hygrograph.

UNIT-II: Radiation and temperature instruments: working principles of albedometer, photometer, spectro-radiometer, sunshine recorder, quantum radiation sensors, thermographs, and infra-red thermometer.

UNIT-III: Precipitation, dew and wind instruments: working principles of rain gauge, self recording rain gauge, Duvdevani dew gauges, anemometer, wind vane and anemograph.

UNIT-IV: Evapotranspiration and photosynthesis instruments: working principles of lysimeters, open pan evaporimeters, porometer, photosynthesis system, leaf area meter and pressure bomb apparatus.

UNIT-V: Soil thermometers, soil heat flux plates and instruments for measuring soil moisture.

UNIT-VI: Automatic weather station ï data logger and sensors, nano-sensors for measurement of weather variables; computation and interpretation of data.

Practical

- Working with the above instruments
- Computation and interpretation of the data

Suggested Readings

Anonymous. 1987. *Instructions to Observers at Surface Observatories*. Part I, IMD, New Delhi.

Byers HR. 1959.*General Meteorology*. McGraw Hill.

Ghadekar SR. 2002. *Practical Meteorology: Data Acquisition Techniques, Instruments and Methods*. Agromet Publ.

Middleton WE & Spilhaws AF. 1962. *Meteorological Department*. University of Toronto Press.

Tanner CB. 1973. *Basic Instrumentation and Measurements for Plant Environment and Micrometeorology*. University of Wisconsin, Madison.

AGM 505 SOIL WATER BALANCE CLIMATOLOGY 2+1 SEM - II

Objective

To impart the theoretical and practical knowledge of soil water balance and its components

Theory

UNIT-I: Basic Laws of radiation; radiation interaction with plant environment; energy balance in atmosphere and crop canopy.

UNIT-II: Atmosphere near the ground; laminar and turbulent flows; wind profile near the ground.

UNIT-III: Theories of evapotranspiration and their comparison; aerodynamic, eddy correlation, energy balance, water balance and other methods, their application under different agroclimatic conditions; concepts of potential, reference and actual evapotranspiration; modified techniques.

UNIT-IV: Influence of microclimate, plant, soil and cultural factors on ET; techniques of lysimetry in measuring actual evapotranspiration.

UNIT-V: Crop coefficients; irrigation scheduling based on evapotranspiration; water use efficiency and its management, dry matter, yield-ET functions; estimation of evapotranspiration through satellite imageries ï MODIS, TERRA, AQUA, AVHRR, NOVA etc.

Practical

- Measurement and evaluation of radiation components
- Measurement of wind and temperature profiles near the ground

Å Computation and comparison of evapotranspiration by different methods - energy balance method, aerodynamic method, Penman method, remote sensing and other methods

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Burman R & Pochop LO. 1994. *Evaporation, Evapotranspiration and Climatic Data*. Elsevier.

Grace J.1983. *Plant Atmospheric Relationships: Outline Studies in Ecology*. Chapman & Hall.

Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture.* The Haworth Press.

Murthy VRK. 2002. *Basic Principles of Agricultural Meteorology*. BS Publ.

Ram Niwas, Diwan Singh & Rao VUM. 2000. *Practical Manual on Evapotranspiration*. Dept. of Agril. Meteorology, CCS HAU Hisar.

Rosenberg NJ, Blad BL & Verma SB. 1983. *Microclimate – The Biological Environment*. John Wiley & Sons.

AGM 506/ AGRON 603 CROP PRODUCTION AND SYSTEM MODELING 1+2 SEM - II

(To be taught jointly by Agricultural Meteorology and Agronomy)

Objective

To impart the theoretical and practical knowledge of various models for estimation of crop responses.

Theory

UNIT-I: Principles of crop production; evaluation of crop responses to weather elements; impact of natural and induced variability of climate on crop production.

UNIT-II: Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relations.

UNIT-III: Potential production: leaf and canopy CO_2 assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.

UNIT-IV: Empirical and statistical crop weather models, their application with examples; regression models- incorporating weather, soil, plant and other environmental related parameters and remote sensing inputs; growth and yield prediction models; crop simulation models, e. g. CERES, WOFOST, SPAW, RESCAP, WTGROW etc.; verification, calibration and validation of models; models for forecasting of pests and diseases.

Practical

- Simulation of elementary models for crop growth
- Simulation of potential production
- Simulation with limitations of water and nutrient management options
- Sensitivity analysis using different climatic elements and crop management practices
- Working with statistical and simulation models, DSSAT models, BRASSICA, RESCAP etc.

Suggested Readings

DeWit CT, Brouwer R & de Vries FWTP. 1970. The Simulation of Photosynthetic Systems. pp. 7-70. In. *Prediction and Measurement of Photosynhetic Activity*. Proc. Int. Biological Programme Plant Physiology Tech. Meeting Trebon PUDOC. Wageningen.

Duncan WG. 1973. SIMAI- A Model Simulating Growth and Yield in Corn. In: *The Application of Systems Methods to Crop Production* (D.N. Baker, Ed.). Mississippi State Univ. Mississipi.

Gordan G. 1992. *System Simulation*. 2nd Ed. Prentice Hall.

Keulen H Van & Seligman NG. 1986. *Simulation of Water Use, Nitrogen Nutrition and Growth of a Spring Wheat Crop.* Simulation Monographs. PUDOC, Wageningen.

Penning de Vries FWT & Van Laar HH. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.

Ritchie JT & Hanks J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.

Zeigler BP. 1976. *Theory of Modeling and Simulation*. John Wiley & Sons.

AGM 507/ FSC 513 WEATHER MODIFICATION AND RISK MANAGEMENT STRATEGIES **2+0** **SEM - I**

Objective

To impart the theoretical and practical knowledge of weather modification techniques with risk management strategies.

Theory

UNIT-I: Historical reviews and theories of weather modification, present status of weather modification for agriculture; horticulture; atmospheric composition and green house effect.

UNIT-II: Scientific advances in clouds and electrical behavior of clouds; hails suppression, dissipation of fog, modification of frost intensity and severe storms; shelter belts and wind breaks, mulches and anti-transpirants; protection of plants against climatic hazards; air and water pollution; meteorological conditions in artificial and controlled climates - green, plastic, glass and animal houses etc.

UNIT-III: Risk characterization - definitions and classification of risks; characterization of weather and climate related risks in agriculture and horticulture in the region concerned; water related risks; radiation/heat related risks; air and its movement related risks; biomass related risks; social and economic risk factors related to weather and climate.

UNIT-IV: Approaches, tools and strategies to deal with risks; Methods for weather and climate related risk assessments; mitigating practices before occurrence; preparedness for the inevitable; contingency planning and responses; disaster risk mainstreaming.

UNIT-V: Perspectives for farm applications - farm applications not yet dealt with, such as making risk information products more client friendly and transfer of risk information products to primary and secondary users of such information; challenges for developing coping strategies including transferring risks through insurance schemes; application of methods that permit the incorporation of seasonal and long-term forecasts into the risk assessment models.

Suggested Readings

Anonymous 2003. *Critical Issues in Weather Modification Research Board of Atmospheric Science and Climate*. National Research Council, USA.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Chritchfield HJ. 1994. *General Climatology*. Prentice Hall.

Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.

Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture.* The Haworth Press.

Mavi HS. 1994. *Introduction to Agrometeorology*. Oxford & IBH.

Menon PA. 1989. *Our Weather.* National Book Trust.

Pearce RP. 2002. *Meteorology at the Millennium.* Academic Press.

Rosenberg NJ, Blad BL & Verma SB. 1983. *Microclimate – The Biological Environment.* John Wiley & Sons.

Samra JS, Pratap Narain, Rattan RK & Singh SK. 2006. *Drought Management in India*. Bull. Indian Society of Soil Science 24, ISSS, New Delhi.

AGM 508 PRINCIPLES OF REMOTE SENSING AND ITS APPLICATIONS IN AGRICULTURE **2+1** **SEM - II**

Objective

To impart the theoretical and practical knowledge of remote sensing principles and their use to estimate of agro-meteorological variables.

Theory

UNIT-I*:* Basic components of remote sensing- signals, sensors and sensing systems; active and passive remote sensing.

UNIT-II: Characteristics of electromagnetic radiation and its interaction with matter; spectral features of earth's surface; remote sensors in visible, infrared and microwave regions.

UNIT-III: Imaging and non-imaging systems; framing and scanning systems; resolution of sensors; sensor platforms, their launching and maintenance.

UNIT-IV: Data acquisition system, data processing, storage and dissemination; digital image processing and information extraction.

UNIT-V: Microwave remote sensing; visual and digital image interpretation; introduction to GIS and GPS.

UNIT-VI: Digital techniques for crop discrimination and identification; crop stress detection - soil moisture assessment, inventory of ground water and satellite monitoring of crop disease and pest infestation.

UNIT-VII: Soil resource inventory; land use/land cover mapping and planning; integrated watershed development; crop yield modeling and crop production forecasting.

Practical

- Å Acquisition of maps
- Å Field data collection
- Å Map and imagery scales
- Å Software and hardware requirements and specifications for remote sensing
- Å Data products, their specifications, media types, data inputs, transformation, display types, image enhancement
- Å Image classification methods
- Å Evaluation of classification errors
- Å Crop discrimination and acreage estimations
- Å Differentiation of different degraded soils
- Å Time domain reflectometry
- Å Use of spectrometer and computation of vegetation indices
- Å Demonstration of case studies

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Colwell RN. (Ed.*). Manual of Remote Sensing*. Vols. 1, II. Am. Soc. Photogrammetry, Virginia.

Curan PJ. *Principles of Remote Sensing*. ELBS/Longman.

Georg Joseph 2005. *Fundamentals of Remote Sensing*. University Press (India).

Jain AK. 1989. *Fundamentals of Digital Image Processing*, Prentice Hall of India.

Narayan LRA. 1999. *Remote Sensing and its Applications*. Oscar Publ.

Patel AN & Surender Singh 2004. *Remote Sensing: Principles and Applications*. Scientific Publ.

AGM 509 APPLIED AGRICULTURAL CLIMATOLOGY 1+2 SEM - I

Objective

To impart the theoretical and practical knowledge of computation of different bio-climatic parameters and their applications in the agriculture.

Theory

UNIT-I: Climatic statistics: measures of central tendency and variability, skewness, kurtosis, homogeneity, correlation, regression and moving averages; probability analysis using normal, binomial, Markov-chain and incomplete gamma distribution; parametric and non parametric tests; assessment of frequency of disastrous events.

UNIT-II: Hydrological cycle: precipitation intensity, evaporation, infiltration, runoff, soil storage and hydrological balance.

UNIT-III: Climatic water budget: potential and actual evapotranspiration and their computation; measurement of precipitation, calculation of water surplus and deficit; computation of daily and monthly water budget and their applications; assessment of dry and wet spells, available soil moisture, moisture adequacy index and their applications.

UNIT-IV: Thermal indices and phenology: cardinal temperatures; heat unit and growing degree day concepts for crop phenology, crop growth and development; insect-pest development; crop weather calendars; agroclimatic requirement of crops.

UNIT-V: Bioclimatic concepts: evaluation of human comfort, comfort indices (temperature, humidity index and wind chill) and clothing insulation; climate, housing and site orientation; climatic normals for animal production.

Practical

- Å Use of statistical approaches in data analysis
- Å Preparation of climatic water budget
- Å Estimation of agroclimatic indices using historical records
- Å Degree day concept and phenology forecasting and preparation of crop calendar
- Å Evaluation of radiation, wind and shading effects in site selection and orientation

- Study of weather-pest and disease interactions, calculation of continentality factors; calculation of comfort indices and preparation of climograph.

Suggested Readings

Anonymous 1980. *ICRISAT Climatic Classification – A Consultation Meeting*. ICRISAT.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Lal DS. 1989. *Climatology*. Chaitanya Publ. House.

Mather JR. 1977. *Work Book in Applied Climatology*. Univ. of Delware, New Jersey.

Mavi HS & Tupper Graeme J. 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture*. The Haworth Press.

Raj Singh, Diwan Singh & Rao VUM. 2006. *Manual on Applied Agricultural Climatology*. Dept of Agril Meteorology, CCS HAU Hisar, India.

Subramaniam VP. 1977. *Incidence and Spread of Continental Drought*. WMO/IMD Report No. 2, WMO, Geneva, Switzerland.

Thompson R. 1997. *Applied Climatology: Principles and Practice*. Routledge.

Walter J Saucier 2003. *Principles of Meteorological Analysis*. Dover Phoenix Eds.

AGM 601 CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT 2+1 SEM - I

Objective

To impart the theoretical and practical knowledge of climate change and their sources.

Theory

UNIT-I: Climate change and global warming: definitions of terms; causes of climate change and global warming; greenhouse gases, ozone depletion; past records, present trends, extreme weather events and future projections; astronomical predictions: lunar cycle, sunspot cycle, solar-lunar tides, Chandlers compensation, blocking highs.

UNIT-II: Impacts of climate change on various systems: impacts resulting from projected changes on agriculture and food security; hydrology and water resources; terrestrial and freshwater ecosystems; coastal zones and marine ecosystems; human health; human settlements, energy, and industry; insurance and other financial services; climate change and crop diversification, loss of biodiversity, microbes and pest dynamics; climate change and storage, climate change and weed management.

UNIT-III: Sensitivity, adaptation and vulnerability: systemôs sensitivity, adaptive capacity and vulnerability to climate change and extreme weather events; regional scenarios of climate change and variability.

UNIT-IV: Mitigation strategies for sustainable development: international policies, protocols, treaties for reduction in greenhouse gases and carbon emissions; carbon sequestration; carbon credit; clean development mechanism (CDM) and land use, land use change and forestry mechanism, alternate energy sources etc.

UNIT-V: Agricultural food security: reduction in carbon and GHG emission; fuel conservation and reduction in energy use, conservation tillage, biofuels for fossil fuels, reduction in machinery use etc; increasing carbon sinks; resource conservation technologies, mixed rotations of cover and green manure crops, minimization of summer fallow and no ground cover periods etc.

Practical

- Case studies on various climatic projections and consequences thereof in relation to agriculture
- Advance methodology of assessing the impact of climate change on crops

Suggested Readings

Anonymous. *Clean Development Mechanism: Building International Public-Private Partnership under Kyoto Protocol*. UNEP, UNDP Publ.

Anonymous. *IPCC Assessment Reports on Climate Change (2001, 2007)*. WMO, UNEP Publ.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Jepma CJ & Munasinghe M. 1998. *Climate Change Policy: Facts, Issues and Analysis*. Cambridge Univ. Press.

Mintzer IM. 1992. *Confronting Climate Change: Risks, Implications and Responses.* Cambridge Univ. Press.

Pretty J & Ball A. 2001. *Agricultural Influence on Carbon Emission and Sequestration: A Review of Evidence and the Emerging Trading Options*. Univ. of Essex.

Pretty JN. 1995. *Regenerating Agriculture: Policies and Practices for Sustainable and Self Reliance*. Earthscan.
Salinger J, Sivkumar MVK & Motha RP. 2005. *Increasing Climate Variability of Agriculture and Forestry*. Springer.
Sinha SK. 1998. *Dictionary of Global Climate Change*. Commonwealth Publ.

AGM 602 WEATHER FORECASTING 2+1 SEM - II

Objective

To impart theoretical and practical knowledge of forecasting techniques used for weather prediction and preparation of agro-advisories.

Theory

UNIT-I: Weather forecasting system: definition, scope and importance; types of forecasting: short, medium and long-range; study of synoptic charts with special reference to location of highs and lows, jet streams, synoptic features and weather anomalies and zones of thermal advection and interpretation of satellite pictures of clouds in visible and infra-red range; weather forecasting network.

UNIT-II: Approaches for weather forecasts: methods of weather forecasts - synoptic, numerical prediction, statistical, analogue, persistence and climatological approach, nano-technological approach, Indigenous Technical Knowledge (ITK) base- signals from flora, fauna, insects, birds, animals behavior; various methods of verification of location-specific weather forecast.

UNIT-III: Weather based advisories: interpretation of weather forecasts for soil moisture, farm operations, pest and disease development and epidemics, crops and livestock production; preparation of weather-based advisories and dissemination.

UNIT-IV: Special forecasts: special forecasts for natural calamities such as drought, floods, high winds, cold (frost) and heat waves, hail storms, cyclones and protection measures against such hazards.

UNIT-V: Modification of weather hazards: weather modification for agriculture; scientific advances in artificial rain making, hail suppression, dissipation of fog and stratus clouds, modification of severe storms and electric behavior of clouds.

Practical

- Exercise on weather forecasting for various applications
- Preparation of weather-based agro-advisories using various approaches and synoptic charts.

Suggested Readings

Alan Watts 2005. *Instant Weather Forecasting*. Water Craft Books.
Ram Sastry AA. 1984. *Weather and Weather Forecasting*. Publication Division, GOI, New Delhi.
Singh SV, Rathore LS & Trivedi HKN. 1999. *A Guide for Agrometeorological Advisory Services*. Department of Science & Technology, NCMRWF, New Delhi.
Wegman & Depriest 1980. *Statistical Analysis of Weather Modification Experiments*. Amazon Book Co.

AGM 603 AIR POLLUTION METEOROLOGY 2+1 SEM - I

Objective

To impart the theoretical and practical knowledge of air pollution.

Theory

UNIT-I: Introduction to air pollution- history, definition: clean air definition; natural versus polluted atmosphere; atmosphere before the industrial revolution.

UNIT-II: Sources of air pollution; classification and properties of air pollutants; emission sources, importance of anthropogenic sources; behaviour and fate of air pollutants; photochemical smog; pollutants and trace gases.

UNIT-III: Meteorological factors in the dispersion of air pollutants; topographical, geographical and large scale meteorological factors attached air pollution; meteorological conditions and typical plume forms; air pollution forecasting ï Gaussian diffusion models, Numerical dispersion models.

UNIT-IV: Air quality standards; effect of air pollution on biological organisms; ozone layer depletion; air pollution control technologies; management of air pollution; principles of diffusion of particulate matter in the atmosphere; air pollution laws and standards.

UNIT-V: Air pollution sampling and measurement: types of pollutant sampling and measurement, ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants, stock sampling; analysis of air pollutants - sulfur dioxide, nitrogen dioxide, carbon monoxide, oxidants and ozone, hydrocarbons, particulate matter.

UNIT-VI: Scales of air pollution: local, urban, regional, continental and global.

Practical

- Measurement of different air pollutants
- Measurement of visibility
- Measurement of ozone and Aerosol Optical Thickness (AOT)
- Study of temperature profile at different heights for determination of stability of the atmosphere
- To determine height of partial flume through chimani
- To study the effect of temperature on vegetables, orchards and agricultural crops

Suggested Readings

Arya SP. 1998. *Air Pollution Meteorology and Dispersion*. Oxford Univ. Press.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Chhatwa GR. 1989. *Environmental Air Pollution and its Control*. Anmol Publ.

Mishra PC. 1990. *Fundamentals of Air and Water Pollution.* Ashish Publ.

Mudd J Brian & Kozlowski TT. (Ed.). 1975. *Responses of Plants to Air Pollution*. Academic Press.

Pickett EE. 1987. *Atmospheric Pollution.* Hemisphere Publ. Corp.

Sharma SH & Khan TI. 2004. *Ozone Depletion and Environmental Impacts*. Pointer Publ.

Weber E. 1982. *Air Pollution Assessment Methodology and Modeling*. Plenum Press.

Yunus M & Iqbal M. (Eds.). 1996. *Plant Response to Air Pollution*. John Wiley & Sons.

AGM 604 WEATHER, CLIMATE AND LIVESTOCK 2+1 SEM - II

Objective

To impart the theoretical and practical knowledge of weather, climate for livestock management.

Theory

UNIT-I: Thermal balance in animals; energy exchange processes at the skin of the animals and the need for the maintenance of thermal balance in the animals.

UNIT-II: Effects of weather on animal production, loss of water from the body, growth rate and body weight, reproduction, grazing habit, food intake, milk production, sun burns and photosensitive disorders.

UNIT-III: Meteorological conditions prevailing in animal shed, poultry house and grain storage barns; heating, cooling and ventilation of these structures as governed by meteorological factors.

UNIT-IV: Weather and animal diseases and parasites; diseases of poultry and its relation with weather and thermal comfort.

UNIT-V: Management of livestock to reduce greenhouse gas emission.

Practical

- Measurement of temperature, humidity and net radiation
- Calculation of animal comfort zone index
- Radiation of animal farm house and body
- Estimation of energy fluxes on body
- Measurements of CO2 and methane in animal farm house

Suggested Readings

Kaiser HM & Drennen TE. (Eds). 1993. *Agricultural Dimensions of Global Climate Change*. St. Lucie Press, Florida.

Monteith L & Unsworth M. 2007. *Principles of Environmental Physics*. 2nd Ed. Academic Press.

Takahashi J, Young BA, Soliva CR & Kreuzer M. 2002. *Greenhouse Gases and Animal Agriculture.* Proc. 1st International Conference on Greenhouse Gases and Animal Agriculture.

Tromp SW. 1980. *Biometeorology. The Impact of the Weather and Climate on Humans and their Environment. (Animals & Plants)*. Heyden & Son.

AGM 605 ANALYTICAL TOOLS AND METHODS FOR AGRO-METEOROLOGY 2+1 SEM - I

Objective

To impart the theoretical and practical knowledge of new tools for analysis of agro-climatic features.

Theory

UNIT-I: Review of agro-climatic approaches; characterization of agroclimatic elements; sampling of atmosphere; temporal and spatial considerations; micro-meso-macro climates.

UNIT-II: Network spacing; spatial and temporal methods; GIS fundamentals and applications; numerical characterization of climatic features; crop response to climate, time lags, time and distance constants, hysteresis effects.

UNIT-III: Influence of climate on stress-response relations; thermal time approach in agroclimatology - heat and radiation use efficiency in crop plants; applications to insect-pest development and prediction; comfort indices for human and animals; impact of natural and induced variability and change of climate on crop production.

UNIT-IV: Instrumentation and sampling problems; design of agro-meteorological experiments.

UNIT-V: Basic knowledge of application of computers in agriculture; theories of computer language BASIC, FORTRAN, C, C++ and Visual basic.

UNIT-VI: Empirical and statistical crop weather models and their application with examples; incorporating weather, soil, plants and other environment related parameters as subroutine and remote sensing inputs in models; growth and yield prediction models; crop simulation models; forecasting models for insects and diseases.

Practical

- Å Calculation of continentality factors
- Å Climatic indices and climogram
- Å Agrometeorological indices: Degree-days, photothermal units, heliothermal units, phenothermal index
- Å Crop growth rates
- Å Analysis of thermogram, hygrogram, hyetogram, sunshine cards etc. stream lines and wind roses and statistical analysis of climatic data
- Å Working with statistical models: crop yield forecasting, crop weather relationship and insect & disease forecasting models
- Å Working with crop simulation models
- Å Small programme writing in computer languages like BASIC, FORTRAN, C, C++ and Visual basic
- Å Geographical Information System

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Cooper M. 2006. *The Spirit of C. An Introduction to Modern Programming*. Jaico Publ.

Malczewski J. 1999. *GIS and Multicriteria Decision Analysis*. John Wiley & Sons.

AGM 606 STRATEGIC USE OF CLIMATIC INFORMATION 2+1 SEM - II

Objective

To impart the theoretical and practical knowledge of climatic hazards and their mitigations.

Theory

UNIT-I: Increasing awareness on potential climate hazards and mitigations: history of climate-related disasters (hazards and vulnerabilities) suffered in the concerned continent/region / country/sub-region and their documented or remembered impacts; hazards and their relation to agricultural production risks (intra- and inter-annual); efforts made in protection mitigating impacts of (future) disasters (prevention); trends discernable in occurrence and character of disasters, if any.

UNIT-II: Selection of appropriate land use and cropping patterns: present land use and cropping patterns in the continent/region/country/sub-region concerned as related to environmental issues; outlook for present land use and cropping patterns and possible alternatives from an environmental point of view.

UNIT-III: Preparedness strategies in agricultural production; preparedness for meteorological disasters in development planning; permanent adaptation strategies that reduce the vulnerabilities to hazards; preparedness as a coping strategy.

UNIT-IV: Making more efficient use of agricultural inputs: agro-meteorological aspects of agricultural inputs and determination of input efficiencies; other factors determining inputs and input efficiency of the region.

UNIT-V: Selection of livestock management: livestock management patterns in the continent/region/country/sub-region concerned as related to environmental issues; outlook for present livestock management strategies and possible alternatives from an environmental point of view; recent trends in livestock management strategies.

UNIT-VI: Adoption of microclimate modification techniques: microclimate modification techniques practiced in the continent/country/sub-region concerned; possible improvements in adoption of microclimate modification techniques, in view of climate variability and climate change; local trends in adoption of such techniques.

Practical

- Å Outlook for present land use and cropping patterns and possible alternatives from environmental point of view
- Å Recent trends in land use and cropping patterns
- Å Agro-meteorological services to increase farmers design abilities of land use and cropping patterns
- Å Systematic and standardized data collection on protection measures against extreme climate

Suggested Readings

Anonymous. *Clean Development Mechanism: Building International Public-Private Partnership under Kyoto Protocol.* UNEP, UNDP Publ.

Anonymous. *IPCC Assessment Reports on Climate Change Policy: Facts, Issues and Analysis*. Cambridge Univ. Press.

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Pretty J & Ball A. 2001. *Agricultural Influence on Carbon Emission and Sequestration: A Review of Evidence and the Emerging Trading Options*. Univ. of Essex.

Pretty JN. 1995. *Regenerating Agriculture: Policies and Practices for Sustainable and Self Reliance*. Earthscan.

Sinha SK. 1998. *Dictionary of Global Climate Change*. Commonwealth Publ.

AGM 607/ STAT 511 STATISTICAL METHODS FOR APPLIED SCIENCES 3+1 SEM - I, II

(To be taught by Statistics)

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, tests of significance, regression and multivariate analytical techniques.

Theory

UNIT-I: Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability, Random variable and mathematical expectation.

UNIT-II: Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications, concept of sampling distribution: chi-square, t and F distributions,. Tests of significance based on Normal, chi-square, t and F distributions. Large sample theory.

UNIT-III: Introduction to theory of estimation and confidence-intervals. 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. Polynomial regression models and their fitting.

UNIT-IV: Non-parametric tests- sign, Wilcoxen, Mann-Whitney U-test. Kruskal-Wallis test, run test, Friedman two-way ANOVA by ranks. Kendallõs coefficient of concordance,

UNIT-V: Introduction to multivariate statistical analysis.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ï Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions-chi-square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis. Non-parametric tests.

Suggested Readings

Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.

Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.

Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.

Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.

Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*. Macmillan.

Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.

Siegel S, Johan N & Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.

AGM 608 DATABASE MANAGEMENT AND COMMERCIALIZATION OF AGROMETEOROLOGICAL DATA IN E-SERVICES 1+2 SEM - II

Objective

To impart knowledge on management of agromet data and train the students in commercialization of agrometeorological data through e-services.

Theory

UNIT-I: Data and information; types of data; climate, soil and crop data; Importance of database management; data requirements; data collection and recording (Automatic and manual).

UNIT-II: Data structure/format; quality control of data; techniques of climatic data generation; missing data; introduction to different software for database management.

UNIT-III: Remote sensing data- maps, imageries and digital data of crop, soil and weather variables

UNIT-IV: Processing and analysis of data and data products; value addition of data and data products; data users, public, commercial, academic or research.

UNIT-V: Availability, accessibility and security of data; evaluating the cost of data; e-management of data.

Practical

- Types of instruments and data recording
- AWS data retrieval, storage and transfer
- Exposure to different software for Agromet data analysis; exposure to Statistical software
- Remote sensing data analysis, temporal and spatial analysis of data; exposure to GIS
- Value addition to data; Introduction to internet protocols
- Uploading and downloading data, password and security of data
- e-management of data

Suggested Readings

Ghadekar R. 2002. *Practical Meteorology – Data Acquisition Techniques, Instruments and Methods*. 4th Ed. Agromet Publ.

IMD/ WHO. 1988. *Users Requirements for Agrometeorological Services*. IMD.

Miles MB & Huberman AM. 1994. *Qualitative Data Analysis*. Sage Publ.

Panse VG & Sukhatme PV. 1983. *Statistical Methods for Agricultural Workers,* ICAR.

Potter GB. 1994. *Data Processing: An Introduction.* Business Publ.

Ramakrishnan R. & Gehrke J. 2003. *Database Management System.* McGraw-Hill.

AGRICULTURAL METEOROLOGY

List of Journals

- Agricultural and Forest Meteorology
- Agricultural Systems
- Agricultural Systems and Information Technology Newsletter
- Agronomy Journal
- Atmospheric Research
- Canadian Water Resource Journal
- Climate Dynamics
- Climate Research
- Climatic Change
- Computers and Electronics in Agriculture
- Crop Science
- Ecological Modelling
- Environmental Monitoring and Assessment
- GIS India
- Hydrology Journal
- Indian Journal of Environmental Protection
- International Journal of Climatology
- International Journal of Remote Sensing
- Italian Journal of Agrometeorology
- Journal of Agricultural Meteorology
- Journal of Agrometeorology
- Journal of Applied Meteorology
- Journal of Applied Hydrology
- Journal of Applied Meteorology and Climatology
- Journal of Earth Systems Science
- Journal of Hydrologic Engineering
- Journal of Hydrometeorology
- Journal of Weather Modification Association
- Mausam
- Monthly Climatological Data for the World
- Photonirwachak
- Pollution Research
- Remote Sensing of Environment
- Vatavaran
- Vayu Mandal
- Water Resource Research
- Weather
- Weather and Forecasting
- WMO Bulletin

Suggested Broad Topics for Master's and Doctoral Research

- Microclimatic studies in crops and control climate
- Crop-weather interaction studies in field, vegetable and horticultural crops
- Crop-weather-pest interaction studies
- GIS approach in agro-ecological zoning and crop environment characterization
- Testing and validation of various existing crop simulation models to determine the production potentials in different regions of the state for major crops
- Climate change and sustainability ï regional scenarios
- Weather modification studies
- Development of weather based model for major crops of the state
- The crop acreage and yield estimates for state using remote sensing approach

- Studies involving the ground-based spectral signatures for stress detection and yield modeling of important crops in the state
- Weather-based agro advisories, impact assessment and related issues
- Impact assessment studies in livestock and other agricultural production systems
- Evapo-transpiration studies using different approaches
- Extreme weather events, their impact on agriculture and their alleviation
- Agro-climatic resource characterization with reference to crops
- Crop-weather relationship for major crops
- Crop-growth simulation modeling
- Development of weather-based forewarning models for pest and disease
- Impact of climate change on agriculture
- Application model based agro-advisories to farmers
- Application of remote sensing in large scale crop condition assessment and yield prediction

AGRONOMY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
AGRON 501*	MODERN CONCEPTS IN CROP PRODUCTION	3+0	I
AGRON 502*	PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT	2+1	II
AGRON 503*	PRINCIPLES AND PRACTICES OF WEED MANAGEMENT	2+1	I
AGRON 504*	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	2+1	I
AGRON 505/ ❶ AGM 502	FUNDAMENTALS OF AGRICULTURAL METEOROLOGY	2+1	I
AGRON 506	AGRONOMY OF MAJOR CEREALS AND PULSES	2+1	I
AGRON 507	AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS	2+1	II
AGRON 508/ ❷ PSMA 503	AGRONOMY OF MEDICINAL, AROMATIC AND UNDER UTILIZED CROPS	2+1	II
AGRON 509	AGRONOMY OF FODDER AND FORAGE CROPS	2+1	II
AGRON 510 ❸	AGROSTOLOGY AND AGROFORESTRY	2+1	I
AGRON 511	CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE	2+0	I
AGRON 512	DRYLAND FARMING AND WATERSHED MANAGEMENT	2+1	I
AGRON 513	PRINCIPLES AND PRACTICES OF ORGANIC FARMING	2+1	II
AGRON 591	MASTERôS SEMINAR	1	I, II
AGRON 599	MASTERôS RESEARCH	20	I, II
AGRON 601**	CURRENT TRENDS IN AGRONOMY	3+0	II
AGRON 602	CROP ECOLOGY	2+0	II
AGRON 603/ ❹ AGM 506	CROP PRODUCTION AND SYSTEM MODELING	1+2	II
AGRON 604**	ADVANCES IN CROP GROWTH AND PRODUCTIVITY	2+1	II
AGRON 605	IRRIGATION MANAGEMENT	2+0	II
AGRON 606	ADVANCES IN WEED MANAGEMENT	2+0	I
AGRON 607	INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE	2+0	II
AGRON 608	SOIL CONSERVATION AND WATERSHED MANAGEMENT	2+1	I
AGRON 609	STRESS CROP PRODUCTION	2+1	I
AGRON 691	DOCTORAL SEMINAR I	1	I, II
AGRON 692	DOCTORAL SEMINAR II	1	I, II
AGRON 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSES			
ABM 520	MANAGEMENT OF AGRO-CHEMICAL INDUSTRY	2+0	
PSMA 603	ADVANCES IN MEDICINAL AND AROMATIC CROP PRODUCTION TECHNOLOGY	2+1	

*Compulsory for Masterôs programme; **Compulsory for Doctoral programme and additional at least one more course from 600 series

To be taught by: ❶ Agrometeorology; ❷ Agronomy; ❸ Forestry and Agronomy; ❹ Agrometeorology and Agronomy

AGRONOMY

Course Contents

AGRON 501 MODERN CONCEPTS IN CROP PRODUCTION 3+0 SEM - I

Objective

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

Theory

UNIT-I: Crop growth analysis in relation to environment; geo-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 modeling 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.

Suggested Readings

Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.

Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.

Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.

Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.

Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.

Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

AGRON 502 PRINCIPAL AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT 2+1 SEM - II

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. 60

UNIT-II: Criteria of essentiality of nutrients; Essential plant nutrients ï 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

Å Determination of soil pH, ECE, 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

Suggested Readings

Brady NC & Weil R.R 2002. *The Nature and Properties of Soils.* 13th Ed. Pearson Edu.

Fageria NK, Baligar VC & Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops.* Marcel Dekker.

Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.

Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Yawalkar KS, Agrawal JP & Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

AGRON 503 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT 2+1 SEM - I

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

Suggested Readings

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.

Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.

Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.

Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 2+1 SEM - I

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 polyhouses.

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

Suggested Readings

Lenka D. 1999. *Irrigation and Drainage.* Kalyani.

Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.

Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.

Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

AGRON 505/ AGM 502 **FUNDAMENTALS OF AGRICULTURAL METEOROLOGY** **2+1** **SEM - I**

(To be taught by Agrometeorology)

Objective

To impart the theoretical and practical knowledge of physical processes occurring in relation to plant and atmosphere with advanced techniques.

Theory

UNIT-I: Meaning and scope of agricultural meteorology; components of agricultural meteorology; role and responsibilities of agricultural meteorologists.

UNIT-II: Importance of meteorological parameters in agriculture; efficiency of solar energy conversion into dry matter production; meteorological factors in photosynthesis, respiration and net assimilation; basic principles of water balance in ecosystems; soil-water balance models and water production
functions.

UNIT-III: Crop weather calendars; weather forecasts for agriculture at short, medium and long range levels; agromet advisories, preparation, dissemination and economic impact analysis; use of satellite imageries in weather forecasting; synoptic charts and synoptic approach to weather forecasting.

UNIT-IV: Concept, definition, types of drought and their causes; prediction of drought; crop water stress index, crop stress detection; air pollution and its influence on vegetation.

UNIT-V: Meteorological aspects of forest fires and their control; concepts of mechanistic and deterministic models; general features of dynamical and statistical modeling techniques; weather data and phenology-based approaches to crop modeling; validation and testing of models.

UNIT-VI: Climatic change, green house effect, CO2 increase, global warming and their impact on agriculture; concept and types of drought; climate classification, agro-climatic zones and agro-ecological regions of India.

Practical

- Preparation of crop weather calendars

- Development of simple regression models for weather, pest and disease relation in different crops.
- Preparation of weather based agro-advisories
- Use of automated weather station (AWS)

Suggested Readings

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.

Critchfield HJ.1995. *General Climatology.* Prentice Hall of India.

Kakde JR. 1985. *Agricultural Climatology*. Metropolitan Book Co.

Lal DS.1998. *Climatology*. Sharda Pustak Bhawan.

Lenka D.1998. *Climate, Weather and Crops in India*. Kalyani.

Mavi H.S.1994. *Introduction to Agro-meteorology*. Oxford & IBH.

Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principles and Application of Climate Studies in Agriculture.* Haworth Press.

Variraju R & Krishnamurty 1995. *Practical Manual on Agricultural Meteorology*. Kalyani.

Varshneya MC & Balakrishana Pillai P. 2003. *Textbook of Agricultural Meteorology*. ICAR.

AGRON 506 AGRONOMY OF MAJOR CEREALS AND PULSES 2+1 SEM - I

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

Suggested Readings

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Hunsigi G & Krishna KR. 1998. *Science of Field Crop Production*. Oxford & IBH.

Jeswani LM & Baldev B. 1997. *Advances in Pulse Production Technology*. ICAR.

Khare D & Bhale MS. 2000. *Seed Technology*. Scientific Publ.

Kumar Ranjeet & Singh NP. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.

Pal M, Deka J & Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.

Prasad, Rajendra. 2002. *Text Book of Field Crop Production.* ICAR.

Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.

Singh, SS. 1998. *Crop Management*. Kalyani.

Yadav DS. 1992. *Pulse Crops*. Kalyani.

AGRON 507 AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS 2+1 SEM - II

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 ï Rapeseed and mustard, linseed

UNIT-II: *Kharif* oilseeds - Groundnut, sesame, castor, sunflower, soybean, Safflower

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

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

Practical

- Å Planning and layout of field experiments
- Å Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane
- Å 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
- Å Intercultural operations in different crops
- Å Cotton seed treatment
- Å Working out growth indices (LER, CGR, RGR, NAR, LAD) aggressivity, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems ÅJudging of physiological maturity in different crops and working out harvest index
- Å Working out cost of cultivation of different crops
- Å Estimation of crop yield on the basis of yield attributes
- Å Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities
- Å Determination of oil content in oilseeds and computation of oil yield
- Å Estimation of quality of fibre of different fibre crops 66
- Å Study of seed production techniques in various crops
- Å Visit of field experiments on cultural, fertilizer, weed control and water management aspects
- Å Visit to nearby villages for identification of constraints in crop production

Suggested Readings

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Das PC. 1997. *Oilseed Crops of India*. Kalyani.

Lakshmikantam N. 1983. *Technology in Sugarcane Growing*. 2nd Ed. Oxford & IBH.

Prasad, Rajendra. 2002. *Text Book of Field Crop Production.* ICAR.

Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops.* Oxford & IBH.

Singh SS. 1998. *Crop Management*. Kalyani.

AGRON 508/ PSMA 503 AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS 2+1 SEM - II

Objective

To acquaint students about different medicinal, aromatic and underutilized field crops, their package of practices and processing.

Theory

UNIT-I: Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge.

UNIT-II: Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Mulhati, Isabgol, Rauwolfia, Poppy, *Aloe vera*, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, *Nux vomica*, Rosadle etc).

UNIT-III: Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium).

UNIT-IV: Climate and soil requirements; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco).

UNIT-V: Post harvest handling ï drawing, processing, grading , packing and storage, value addition and quality standards in herbal products.

Practical

- Identification of crops based on morphological and seed characteristics
- Raising of herbarium of medicinal, aromatic and under-utilized plants
- Quality characters in medicinal and aromatic plants
- Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants

Suggested Readings

Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. II. *Medicinal and Aromatic Plants*. Malhotra Publ.

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Handa SS. 1984. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Hussain A. 1984. *Essential Oil Plants and their Cultivation.* CIMAP, Lucknow.

Hussain A. 1993. *Medicinal Plants and their Cultivation.* CIMAP, Lucknow.

ICAR 2006. *Hand Book of Agriculture.* ICAR, New Delhi.

Kumar N, Khader Md. Abdul, Rangaswami JBM & Irulappan 1997. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants.* Oxford & IBH.

Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2003. *A Hand Book of Medicinal Plants: A Complete Source Book*. Agrobios.

Sharma R. 2004. *Agro-Techniques of Medicinal Plants*. Daya Publ. House.

AGRON 509 AGRONOMY OF FODDER AND FORAGE CROPS 2+1 SEM - II

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/grasseslime, napier grass, *Panicum, Lasiuras, 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

Suggested Readings

Chatterjee BN. 1989. *Forage Crop Production - Principles and Practices*. Oxford & IBH.

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Narayanan TR & Dabadghao PM. 1972. *Forage Crops of India*. ICAR.

Singh P & Srivastava AK. 1990. *Forage Production Technology*. IGFRI, Jhansi.

Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.

Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

AGRON 510 AGROSTOLOGY AND AGRO-FORESTRY 2+1 SEM - I

(To be taught jointly by Forestry and Agronomy)

Objective

To teach crop husbandry of different forage, fodder and agroforestry crops/trees along with their processing.

Theory

UNIT-I: Agrostology: definition and importance; principles of grassland ecology: grassland ecology ï community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.

UNIT-II: Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses.

UNIT-III: Agroforestry: definition and importance; agroforestory systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aquasilviculture, alley cropping and energy plantation.

UNIT-IV: Crop production technology in agro-forestory and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

Practical

- Å Preparation of charts and maps of India showing different types of pastures and agro-forestry systems
- Å Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry
- Å Seed treatment for better germination of farm vegetation
- Å Methods of propagation/planting of grasses and trees in silvipastoral system
- Å Fertilizer application in strip and silvipastroal systems
- Å After-care of plantation
- Å Estimation of protein content in loppings of important fodder trees
- Å Estimation of calorie value of wood of important fuel trees
- Å Estimation of total biomass and fuel wood
- Å Economics of agro-forestry
- Å Visit to important agro-forestry research stations

Suggested Readings

Chatterjee BN & Das PK. 1989. *Forage Crop Production. Principles and Practices.* Oxford & IBH.

Dabadghao PM & Shankaranarayan KA. 1973. *The Grass Cover in India*. ICAR.

Dwivedi AP. 1992. *Agroforestry- Principles and Practices.* Oxford & IBH.

Indian Society of Agronomy. 1989. *Agroforestry System in India. Research and Development,* New Delhi.

Narayan TR & Dabadghao PM. 1972. *Forage Crop of India*. ICAR, New Delhi.

Pathak PS & Roy MM. 1994. *Agroforestry System for Degraded Lands*. Oxford & IBH.

Sen NL, Dadheech RC, Dashora LK & Rawat TS. 2004. *Manual of Agroforestry and Social Forestry.* Agrotech Publ.

Shah SA.1988. *Forestry for People*. ICAR.

Singh Panjab, Pathak PS & Roy MM.1994. *Agroforestry System for Sustainable Use*. Oxford & IBH.

Singh SP. 1994. *Handbook of Agroforestry.* Agrotech Publ.

Solanki KR. 2000. *Multipurpose Tree Species: Research, Retrospect and Prospects*. Agrobios.

Tejwani KG.1994. *Agroforestry in India.* Oxford & IBH.

AGRON 511 CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE 2+0 SEM - I

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.

Suggested Readings

Palaniappan SP & Sivaraman K. 1996. *Cropping Systems in the Tropics;Principles and Management.* New Age.

Panda SC. 2003. *Cropping and Farming Systems*. Agrobios.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy.* The Bangalore Printing & Publ. Co.

Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

AGRON 512 DRYLAND FARMING AND WATERSHED MANAGEMENT 2+1 SEM - I

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); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

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

Practical

- Å Seed treatment, seed germination and crop establishment in relation to soil moisture contents
- Å Moisture stress effects and recovery behaviour of important crops
- Å Estimation of moisture index and aridity index
- Å Spray of anti-transpirants and their effect on crops
- Å 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

Suggested Readings

Das NR. 2007. *Tillage and Crop Production*. Scientific Publ.

Dhopte AM. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.

Dhruv Narayan VV. 2002. *Soil and Water Conservation Research in India*.ICAR.

Gupta US. (Ed.). 1995. *Production and Improvements of Crops forDrylands*. Oxford & IBH.

Katyal JC & Farrington J. 1995. *Research for Rainfed Farming*. CRIDA.

Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture.* Scientific Publ.

Singh P & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture.* Agrotech Publ. Company.

Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops*. CRIDA.

Singh RP. 2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.

Singh SD. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publ.

Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR.

AGRON 513 PRINCIPLES AND PRACTICES OF ORGANIC FARMING 2+1 SEM - II

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 and biofertilizers.

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

UNIT-IV: Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT-V: Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Aerobic and anaerobic methods of making compost
- Making of vermicompost
- Identification and nursery raising of important agro-forestry tress and tress 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
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.

Lampin N. 1990. *Organic Farming*. Press Books, lpswitch, UK.

Palaniappan SP & Anandurai K. 1999. *Organic Farming – Theory and Practice.* Scientific Publ.

Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ. 3, Parisaraprajna Parishtana, Bangalore.
Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.
Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies.* PDBC, Bangalore.
Subba Rao NS. 2002. *Soil Microbiology*. Oxford & IBH.
Trivedi RN.1993. *A Text Book of Environmental Sciences*, Anmol Publ.
Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture.* Association for Promotion of Organic Farming, Bangalore.
WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*.WHO.
Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

AGRON 601 CURRENT TRENDS IN AGRONOMY 3+0 SEM - II

Objective

To acquaint the students about recent advances in agricultural production.

Theory

UNIT-I: Agro-physiological basis of variation in yield, recent advances in soilplant-water relationship.

UNIT-II: Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures.

UNIT-III: Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

UNIT-IV: GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

UNIT-V: Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Suggested Readings

Agarwal RL. 1995. *Seed Technology*. Oxford & IBH.
Dahiya BS & Rai KN. 1997. *Seed Technology*. Kalyani.
Govardhan V. 2000. *Remote Sensing and Water Management in Command Areas: Agroecological Prospectives*. IBDC.
ICAR. 2006. *Hand Book of Agriculture*. ICAR.
Narasaiah ML. 2004. *World Trade Organization and Agriculture*. Sonali Publ.
Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.
Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.
Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture* Scientific Publ.

AGRON 602 CROP ECOLOGY 2+0 SEM - II

Objective

To acquaint the students about the agricultural systems, agro-ecological regions, and adaptation of crops to different agro-climatic conditions.

Theory

UNIT-I: Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT-II: Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT-III: Physiological response of crop plants to light, temperature, CO2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT-IV: Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT-V: Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

Suggested Readings

Ambasht RS. 1986. *A Text Book of Plant Ecology*. 9th Ed. Studentsô Friends & Co.

Chadha KL & Swaminathan MS. 2006. *Environment and Agriculture*. Malhotra Publ. House.

Dwivedi P, Dwivedi SK & Kalita MC. 2007. *Biodiversity and Environmental Biotechnology.* Scientific Publ.

Hemantarajan A. 2007. *Environmental Physiology*. Scientific Publ.

Kumar HD. 1992. *Modern Concepts of Ecology*. 7th Ed. Vikas.Publ.

Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.

Misra KC. 1989. *Manual of Plant Ecology*. 3rd Ed. Oxford & IBH.

Pandey SN & Sinha BK. 1995. *Plant Physiology*. Vikas Publ.

Sharma PD. 1998. *Ecology and Environment*. Rastogi Publ.

Singh J & Dhillon SS. 1984. *Agricultural Geography.* Tata McGraw Hill.

Taiz L & Zeiger E. 1992. *Plant Physiology*. Benjamin/Cummings Publ.

AGRON 603/ AGM 506 **CROP PRODUCTION AND SYSTEM MODELING** **1+2** **SEM - II**

(To be taught jointly by Agricultrual Meteorology and Agronomy)

Objective

To impart the theoretical and practical knowledge of various models for estimation of crop responses.

Theory

UNIT-I: Principles of crop production; evaluation of crop responses to weather elements; impact of natural and induced variability of climate on crop production.

UNIT-II: Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams.

UNIT-III: Potential production: leaf and canopy CO2 assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.

UNIT-IV: Empirical and statistical crop weather models their application with examples; regression models- incorporating weather, soil, plant and other environmental related parameters and remote sensing inputs; growth and yield prediction models; crop simulation models, e. g. CERES, WOFOST, SPAW, RESCAP, WTGROW etc.; forecasting of pests and diseases; verification, calibration and validation of models.

Practical

- Å Simulation of elementary models for crop growth
- Å Simulation of potential production
- Å Simulation with limitations of water and nutrient management options
- Å Sensitivity analysis using different climatic years and crop management practices
- Å Working with statistical and simulation models, DSSAT models, BRASSICA, RESCAP

Suggested Readings

DeWit CT, Brouwer R & de Vries FWTP 1970. The Simulation of Photosynthetic Systems, pp. 7-70. In: *Prediction and Measurement of Photosynthetic Activity*. Proc. Int. Biolofical Programme Plant Physiology Tech. Meeting Trebon PUDOC. Wageningen.

Duncan WG. 1973. SIMAI-A Model Simulating Growth and Yield in Corn. In: *The Application of Systems Methods to Crop Production* (D.N. Baker, Ed). Mississippi State Univ. Mississipi.

Gordan G. 1992. *System Simulation.* 2nd Ed. Prentice Hall.

Penning de Vries FWT & Van Laar HH. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.

Keulen H Van & Seligman NG. 1986. *Simulation of Water Use, Nitrogen Nutrition and Growth of a Spring Wheat Crop.* Simulation Monographs. PUDOC, Wageningen.

Ritchie JT & Hanks J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.

Zeigler BP. 1976. *Theory of Modeling and Simulation*. John Wiley & Sons.

AGRON 604 ADVANCES IN CROP GROWTH AND PRODUCTIVITY 2+1 SEM - II

Objective

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

UNIT-I: Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT-II: Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT-III: Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT-IV: Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

- Å Field measurement of root-shoot relationship in crops at different growth stages
- Å Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth
- Å Computation of harvest index of various crops
- Å Assessment of crop yield on the basis of yield attributing characters
- Å Construction of crop growth curves based on growth analysis data
- Å Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping
- Å Senescence and abscission indices
- Å Analysis of productivity trend in un-irrigated areas
- Å Analysis of productivity trend in irrigated areas

Suggested Readings

Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants*. Oxford & IBH.

Delvin RM & Vitham FH. 1986. *Plant Physiology*. CBS Publ.

Evans LT. 1975. *Crop Physiology*. Cambridge Univ. Press.

Evans LT. 1996. *Crop Evolution, Adaptation and Yield*. Cambridge Univ. Press.

Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Gupta US. 1988. *Progress in Crop Physiology*. Oxford & IBH.

Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils.* Academic Press.

Mukherjee S & Ghosh AK. 1996. *Plant Physiology*. Tata McGraw Hill.

Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods.* Scientific Publ.

AGRON 605 IRRIGATION MANAGEMENT 2+0 SEM - II

Objective

To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT-I: Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT-II: Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT-III: Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT-IV: Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT-V: Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT-VI: Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmerôs participation in command areas; irrigation legislation.

Suggested Readings

FAO. 1984. *Irrigation Practice and Water Management.* Oxford & IBH.

Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy*. Oxford & IBH.

Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US.(Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

AGRON 606 ADVANCES IN WEED MANAGEMENT 2+0 SEM - I

Objective

To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

UNIT-I: Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.

UNIT-II: Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT-III: Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT-IV: Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT-V: Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT-VI: Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

Suggested Readings

Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management*. Panama Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley-Inter Science.

Gupta OP. 2000. *Weed Management – Principles and Practices*. Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.

Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.

Ross MA & Carola Lembi A. 1999. *Applied Weed Science.* 2nd Ed. Prentice Hall.

Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 607 INTEGRATED FARMING SYSTEMS SUSTAINABLE AGRICULTURE 2+0 SEM - II

Objective

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

Theory

UNIT-I: Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT-II: Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.

UNIT-III: Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping.

UNIT-IV: Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT-V: New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

Suggested Readings

Ananthakrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.

Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani.

Lampin N. 1990. *Organic Farming*. Farming Press Books.

Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.

Panda SC. 2004. *Cropping systems and Farming Systems*. Agribios.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma AK. 2001. *A Hand Book of Organic Farming*. Agrobios.

Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.

Trivedi RN. 1993. *A Text Book of Environmental Sciences*. Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishtana, Bangalore.

AGRON 608 SOIL CONSERVATION AND WATERSHED MANAGEMENT 2+1 SEM - I

Objective

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

UNIT-I: Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT-II: Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT-III: Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT-IV: Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

UNIT-V: Drainage considerations and agronomic management; rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.

Practical

- Å Study of different types of erosion
- Å Field studies of different soil conservation measures
- Å Run-off and soil loss measurements
- Å Laying out run-off plot and deciding treatments
- Å Identification of different grasses and trees for soil conservation
- Å Visit to a soil conservation research centre, demonstration and training centre

Suggested Readings

Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.

Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.

FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. *Soils Bull.,* Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection.* 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering*. Kalyani.

Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.

Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

AGRON 609 STRESS CROP PRODUCTION 2+1 SEM - I

Objective

To study various types of stresses in crop production and strategies to overcome them.

Theory

UNIT-I: Stress and strain terminology; nature and stress injury and resistance; causes of stress.

UNIT-II: Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature tress through, soil and crop manipulations.

UNIT-III: High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT-IV: Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations.

UNIT-V: Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.

UNIT-VI: Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

UNIT-VII: Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

UNIT-VIII: Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

Practical

- Å Determination of electrical conductivity of plant cell sap
- Å Determination of osmotic potential and tissue water potential
- Å Measurement of transpiration rate
- Å Measurement of stomatal frequency
- Å Growing of plants in sand culture under salt stress for biochemical and physiological studies
- Å Studies on effect of osmotic and ionic stress on seed germination and seedling growth
- Å Measurement of low temperature injury under field conditions

Suggested Readings

Baker FWG.1989. *Drought Resistance in Cereals*. Oxon, UK.

Gupta U.S. (Ed.). 1988. *Physiological Aspects of Dryland Farming.* Oxford & IBH.

Kramer PJ.1983. *Water Relations of Plants*. Academic Press.

Levitt J. 1980. *Response of Plants to Environmental Stresses*. Vols. I, II. Academic Press.

Mavi HS.1978. *Introduction to Agro-meteorology*. Oxford & IBH.

Michael AM & Ojha TP.1981. *Principles of Agricultural Engineering*. Vol II. Jain Bros.

Nilsen ET & Orcut DM. 1996. *Physiology of Plants under Stress – Abiotic Factors*. John Wiley & Sons.
Singh K. 2000. *Plant Productivity under Environmental Stress*. Agribios.
Singh KN & Singh RP. 1990. *Agronomic Research Towards Sustainable Agriculture*. Indian Society of Agronomy, New Delhi.
Somani LL & Totawat KL. 1992. *Management of Salt-affected Soils and Waters.* Agrotech Publ.
Virmani SM, Katyal JC, Eswaran H & Abrol IP.1994. *Stressed Ecosystem and Sustainable Agriculture*. Oxford & IBH.

AGRONOMY

List of Journals

- Advances in Agronomy
- Agricultural Systems
- Agricultural Water Management
- Agriculture, Ecosystems and Environment
- Agronomy Journal
- Annual Review of Plant Physiology
- Applied Ecology and Environment Research
- Australian Journal of Agricultural Research
- Australian Journal of Experimental Agriculture
- Crop Protection
- Environment and Ecology
- European Journal of Agronomy
- Fertilizer Research
- Field Crops Research
- Indian Journal of Agricultural Sciences
- Indian Journal of Agronomy
- Indian Journal of Ecology
- Indian Journal of Weed Science
- Irrigation Science
- Japanese Journal of Crop Science
- Journal of Agricultural Science Cambridge
- Journal of Agronomy
- Journal of Applied Ecology
- Journal of Experimental Botany
- Journal of Farming Systems Research
- Journal of Range Management
- Journal of Sustainable Agriculture
- Netherlands Journal of Agricultural Sciences
- Nutrient Cycling in Agroecosystems
- Pesticide Biochemistry and Physiology
- Plant and Soil
- Plant Production Science
- Soil and Tillage Research
- Swedish Journal of Agricultural Research
- Tropical Agriculture
- Weed Research

Suggested Broad Topics for Master's and Doctoral Research

- Crop diversification under different agricultural situations
- Development of farming systems for marginal, small and other farmers
- Agricultural information at door step/click of mouse
- Farm-specific nutrient management
- Weed management in different cropping/farming systems
- Nutrient studies in different cropping/farming systems
- Biodiversity of farming systems for conservation
- Organic farming systems for different regions
- Modeling for different crop situations
- Conservation agriculture for yield sustainability
- Role of edaphic factors on weeds proliferation and management
- Implications of global warming on weed growth and herbicide behaviour
- Ecological implications of using thresholds for weed management
- Effect of cultivation practices and herbicides on weed flora shift
- GM crops and weed management strategies
- Weed management under reduced moisture regime in major summer/*kharif* crops
- Avoidance of herbicide resistance using IWM

BUSINESS MANAGEMENT

MBA (Agribusiness) and MBA(General)

Course Structure

COURSE NO.	COURSE TITLE	CREDITS
First year, SEM – I		
ABM/MGT 501	PRINCIPLES OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR	3+0
ABM/MGT 502	BUSINESS ENVIRONMENT	2+0
ABM/MGT 503	MANAGERIAL ECONOMICS	3+0
ABM/MGT 504	MANAGERIAL ACCOUNTING AND CONTROL	2+0
ABM/MGT 505	BUSINESS LAWS AND ETHICS	2+0
ABM/MGT 506	HUMAN RESOURCE MANAGEMENT	2+0
ABM/MGT 507	BUSINESS MATHEMATICS AND STATISTICS	2+0
Total Credit Hours		16
First year, SEM – II		
ABM/MGT 508	INTRODUCTION TO AGRIBUSINESS MANAGEMENT	2+0
ABM/MGT 509	MARKETING MANAGEMENT	3+0
ABM/MGT 510	FINANCIAL MANAGEMENT	2+0
ABM/MGT 511	PRODUCTION AND OPERATIONS MANAGEMENT	2+0
ABM/MGT 512	RESEARCH METHODOLOGY	3+0
ABM/MGT 513	OPERATIONS RESEARCH METHODS	2+0
Total Credit Hours		14
Second Year, SEM – I		
ABM/MGT 514	PROJECT MANAGEMENT AND ENTREPRENEUSHIP DEVELOPMENT	2+0
ABM/MGT 595	SUMMER TRAINING/INDUSTRIAL ATTACHMENT*	S/US
Five courses each of 2+0 credit hours from electives**		10
Total Credit Hours		12
Second Year, SEM - II		
ABM/MGT 515	MANAGEMENT INFORMATION SYSTEMS	2+0
ABM/MGT 591	SEMINAR	1
ABM/MGT 599	PROJECT***	10
Three courses each of 2+0 credit hours from electives****		6
Total Credit Hours		19

ELECTIVES
MBA (AGRIBUSINESS MANAGEMENT)

ABM 516	RURAL MARKETING	2+0
ABM 517	AGRICULTURAL MARKETING MANAGEMENT	2+0
ABM 518/ FST 551 ❶	FOOD TECHNOLOGY AND PROCESSING MANAGEMENT	2+0
ABM 519/ SOILS 519 ❷	FERTILIZER TECHNOLOGY AND MANAGEMENT	2+0
ABM 520 ❸	MANAGEMENT OF AGRO CHEMICAL INDUSTRY	2+0
ABM 521	FARM BUSINESS MANAGEMENT	2+0
ABM 522/ SST 517 ❹	SEED PRODUCTION TECHNOLOGY AND MANAGEMENT	2+0
ABM 523/ LPT 516 ❺	TECHNOLOGY MANAGEMENT FOR LIVESTOCK PRODUCTS	2+0
ABM 524/ FSC 514 ❻	FRUIT PRODUCTION AND POST HARVEST MANAGEMENT	2+0
ABM 525/ FMPE 514 ❼	FARM POWER & MACHINERY MANAGEMENT	2+0

ABM 526	INTERNATIONAL TRADE AND SUSTAINABILITY GOVERNANCE	2+0
ABM 527	MANAGEMENT OF AGRIBUSINESS COOPERATIVES	2+0
ABN 528	AGRIBUSINESS FINANCIAL MANAGEMENT	2+0
ABN 529	FOOD RETAIL MANAGEMENT	2+0
ABM 530	MANAGEMENT OF AGRICULTURAL INPUT MARKETING	2+0
ABM 531/ ANN 610 ❽	FEED BUSINESS MANAGEMENT	2+0
ABM 532	AGRI SUPPLY CHAIN MANAGEMENT	2+0
ABM 533/ LPM 614 ❾	POULTRY AND HATCHERY MANAGEMENT	2+0
ABM 534 FLA 509 ❿	MANAGEMENT OF FLORICULTURE AND LANDSCAPING	2+0
ABM 535 / FST 533 ☼	BUSINESS MANAGEMENT AND INTERNATIONAL TRADE	3+0

MBA (GENERAL)

FINANCE		
MGT 516	WORKING CAPITAL MANAGEMENT	2+0
MGT 517	DIRECT TAX LAWS	2+0
MGT 518	FINANCIAL INSTITUTIONS	2+0
MGT 519	STOCK MARKET OPERATIONS	2+0
MGT 520	MERCHANT BANKING AND FINANCIAL SERVICES MANAGEMENT	2+0
MGT 521	SECURITY ANALYSIS & PORTFOLIO MANAGEMENT	2+0
MGT 522	INTERNATIONAL FINANCIAL MANAGEMTNT	2+0
MGT 523	MANAGEMENT CONTROL SYSTEM	2+0
MARKETING MANAGEMENT		
MGT 524	SALES MANAGEMENT	2+0
MGT 525	MARKETING RESEARCH	2+0
MGT 526	CONSUMER BEHAVIOUR	2+0
MGT 527	INTERNATIONAL MAKETING	2+0
MGT 528	ADVERTISING MANAGEMENT	2+0
MGT 529	RETAIL MANAGEMENT	2+0
MGT 530	PRODUCT MANAGEMENT	2+0
MGT 531	STRATEGIC MARKETING	2+0
HUMAN RESOURCE MANAGEMENT		
MGT 532	ORGANISATIONAL DEVELOPMENT AND INTERVENTION STRATEGIES	2+0
MGT 533	UNION MANAGEMENT RELATIONS	2+0
MGT 534	INDUSTRIAL PSYCHOLOGY	2+0
MGT 535	COMPENSATION MANAGEMENT	2+0
MGT 536	ORGANISATIONAL CHANGE AND STRESS MANAGEMENT	2+0
MGT 537	LABOUR ECONOMICS	2+0
MGT 538	INDUSTRIAL AND LABOUR LEGISLATION	2+0
MGT 539	STRATEGIC HUMAN RESOURCE MANAGEMENT	2+0

Note: The course code **ABM** will be for MBA (Agri-Business) and **MGT** will be for MBA (General) programmes, respectively. Each course will be of 100 marks (75 external and 25 internal) except ABM/MGT 595.

* All Students will go for 6-8 week practical summer training in companies after completion of the first year second semester. Students have to present and submit the training report to the Department in the beginning of first semester of second year which will be evaluated internally.

**In Agribusiness programme all five elective courses will be from Agribusiness area. In MBA programme three courses from major and two courses from minor area of specialization will be offered. The areas of specialization for MBA programme will be Marketing, Finance and HRM. However a course will be offered if 25% students of the intake capacity are willing to take up that course.

***Every student will take up a research project in consultation with the advisor/head of the department and will submit a written report to the department before the commencement of second semester examination of second year. External examiner will evaluate and also conduct viva voce based on project report and award marks out of 100.

****In Agribusiness programme all three elective courses will be from Agribusiness area. In MBA programme two courses from major and one course from minor area of specialization will be offered. The areas of specialization for MBA programme will be Marketing, Finance and HRM. However a course will be offered if 25% students of the intake capacity are willing to take up that course.

To be taught by: ❶ Food Science and Technology; ❷ Soil Science; ❸ Entomology, Plant Pathology and Agronomy; ❹ Seed Science and Technology; ❺ Livestock Products Technology; ❻ Fruit Science; ❼ Farm Machinery and Power Engineering; ❽ Animal Nutrition; ❾ Livestock Production Management; ❿ Floriculture and Landscape Architecture; ☼ Business Management

Credit Requirement for MBA

Compulsory	=	34
Electives	=	16
Seminar	=	01
Project	=	10
Total	**=**	**61**
Non Credit Compulsory Courses (NC)	=	05

MBA (Agribusiness) and MBA(General)
Course Contents

ABM/MGT 501 PRINCIPLES OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR 3+0

Objective

To acquaint the learner with meaning and concepts of management and organizational behaviour. Focus will be on understanding the concepts, processes, significance, and role of management and organizational behaviour.

Contents

UNIT-I: Nature, Scope and Significance of Management, Evolution of Management Thought, Approaches to Management, Functions of a Manager, Planning - Types, Steps, Course Objective, Process, Strategies, Policies, MBO, Strategic Planning Process, SWOT analysis, Organizing ï Structure & Process, Line Staff, Authority & responsibility.

UNIT-II: Staffing ï Selection process, Directing ï Training, Communication & motivation, Controlling- Significance, Process, Techniques, Standards & Benchmarks, Management Audit.

UNIT-III: Nature, Scope and Significance of Organizational Behavior; Evolution and Historical Background of Organizational Behavior; Models of Organisational Behaviour Foundations of individual behaviour, Diversity, Micro Organisational behavior - Personality, self-concept, self-esteem and Self-Efficacy; Attitudes, Perception, Power ï types & structures.

UNIT-IV: Motivation- Types of motivation. Theories of motivation, Applications of motivation. Transactional analysis-Johari window-self fulfilling prophecy, Interpersonal relations-understanding, determinants, and developing; leadership styles and influence process; leadership theories; types of leaders, and effective leader; group dynamics-, types of groups, group formation, Group decision making, Team Building.

UNIT-V: Organizational culture or climate-concept, dimensions, ethos, determinants; organizational conflicts-concepts, sources, implications, and management; organizational changes - types, resistances to change, role of change agents.

Suggested Readings

- Fred Luthans 1998. *Organizational Behavior*. Tata McGraw Hill.
- Harold Koontz & Keing Weighhrich. *Essentials of Management*. McGraw Hill.
- John W Newstrom & Keith Davis. 1997. *Human Behaviour at Work*. Tata McGraw.
- Robert C Appleby. 1997. *Modern Business Administration*. Macmillan India.
- Stephen P Robbins 2007. *Organizational Behaviour*. Prentice Hall.
- Stoner James AF. 2005. *Management*. Pearson Edu.

ABM/MGT 502 BUSINESS ENVIRONMENT 2+0

Objective

To expose learner to the environment in which the business is conducted. Focus will be on understanding micro and macro environmental forces and their impact on business.

Contents

UNIT-I: Business Environment and business decisions. Constituents of business environment: Economic Environment, Technological Environment, Infrastructure environment, Socio-Cultural Environment, Social Responsibility of Business.

UNIT-II: Industrial policy, liberlisation, privatisation, globalisation, foreign investment, MNCôs.

UNIT-III: International business environment, WTO.

UNIT-IV: Monetary and Fiscal Policies, Money and Capital Markets. Public, Private, Cooperative and Joint Sectors in India.

UNIT-V: Governmentôs Role in Indian Business, role of various business associations in India.

Suggested Readings

Adhikary M. 1986. *Economic Environment of Business*. S. Chand & Sons.

Aswathappa K. 1997. *Essentials of Business Environment*. Himalaya Publ.

Francis Cherunilam 2003. *Business Environment*. Himalaya Publ.

Justin Paul 2007. *Business Environment*. McGraw Hill.

Saroj Upadhyay. *Business Environment*. Asian Books.

ABM/MGT 503 MANAGERIAL ECONOMICS 3+0

Objective

To familiarize the students with the fundamental economic concepts and principles in the context of managerial decision making.

Contents

UNIT-I**:** Scope of managerial economics, objective of the firm and managerial economics as a tool of decision making; mathematical concepts used in managerial economics.

UNIT-II: Demand analysis - meaning, types and determinants of demand; demand function; demand elasticity; demand forecasting-need and techniques.

UNIT-III: Production, cost and supply analysis- production function, least-cost input combination and returns to scale, cost concepts, cost-output relationship, short and long-run supply functions.

UNIT-IV: Pricing-determinants of price - pricing under different market structures ï perfect competition, monopoly, monopolistic and oligopoly; pricing methods in practice

UNIT-V: The national income; circular flow of income: consumption, investment and saving; economic growth ï meaning and determinants; phases of business cycles; business decisions under uncertainty;

Suggested Readings

Baumol WJ. 1980. *Economic Theory and Operations Analysis*. Prentice Hall of India.

Dernberg Thomas F. *et. al.,* 1986. *Macro Economics: Concepts, Theories and Policies*. McGraw Hill.

Dwivedi DN. 2002. *Managerial Economics*. Vikash Publ. House Pvt. Ltd.

Gupta GS. 1997. *Managerial Economics*. Tata McGraw Hill.

Craig Petersen H & Chris Lewis W. 1996. *Managerial Economics*. Prentice Hall of India.

Koutsoyiannis A. 1989. *Modern Micro Economics*. Mac Millan Press.

Maheshwari Yogesh. 2005. *Managerial Economics*. PHI Learning.

ABM/MGT 504 MANAGERIAL ACCOUNTING AND CONTROL 2+0

Objective

The objective of this course is to expose the learner to the concept and methods of financial and management accounting. Focus will be on understanding techniques, uses and applications of financial and management accounting.

Contents

UNIT-I: Financial Accounting- Meaning, Need, Concepts and Conventions; Branches of Accounting, Internal and External Users of Accounting, Advantages and Limitations of Financial Accounting, Accounting Standards.

UNIT-II: The Double Entry System- Its Meaning and Scope, The Journal, Cash Book, Ledger, Trial Balance, Trading Account, Profit and Loss Account, Balance Sheet, Entries and Adjustments of different heads in different Books and Accounts.

UNIT-III: Management Accounting- Meaning, Functions, Scope, Utility, Limitations and Tools of Management Accounting, Analysis of Financial Statements- Ratios, Comparative and Common Size Statements, Cash Flow and Funds Flow Analysis, Management Audit and Financial

UNIT-IV: Cost Accounting ï Nature, Significance of Cost Accounting; Classification of Cost, Costing for Material, Labour, and Overheads; Introduction to Marginal Costing and cost volume profit Analysis- Its Significance, Uses and Limitations; Standard Costing ï Its Meaning, Uses and Limitations; Determination of Standard Cost, Variance Analysis-Material, Labour and Overhead.

UNIT-V: Responsibility Accounting- Its Meaning and Significance, Cost, Profit and Investment Centres, Accounting for Price Level Changes- Concepts, CPP and CCA Methods. Budget and Budgetary Control- Its Meaning, Uses and Limitations, Budgeting and Profit Planning, Introduction to Different Types of Budgets and their Preparations, Sales Budget, Purchase Budget, Production Budget, Cash Budget, Flexible Budget, Master Budget, Zero Based Budgeting.

Suggested Readings

Horngren. 2008. *Introduction to Financial Accounting*. 8th Ed. Pearson Edu.

Khan MY & Jain PK. 2004. *Management Accounting*. Tata McGraw Hill.

Maheshwari SN & Maheshwari SK. 2003. *Financial Accounting*. 3rd Ed. Vikas Publ. House.

ABM/MGT 505 BUSINESS LAWS AND ETHICS 2+0

Objective

The objective of this course is to expose the learner to various ethical issues and laws affecting business. Focus will be on understanding provisions of various business laws and also ethical practices to conduct the business properly.

Contents

UNIT-I: Introduction to Indian legal system, The Indian Contract Act-1872: Contract-meaning, nature, significance, types of contract, essentials of a valid contract, offer and acceptance, capacity to contract, free consent, performance of contract.

UNIT-II: Companies Act-1956: incorporation, commencement of business, types of companies, management, winding of companies, Negotiable Instruments Act.

UNIT-III: Essential Commodities Act, APMC Act, Consumer Protection Act, RTI Act, MRTP Act- major provisions and implications.

UNIT-IV: Factory Act, Labour laws, Industrial dispute Act.

UNIT-V: Nature and importance of ethics and moral standards; corporations and social responsibilities, scope and purpose of business ethics; Ethics in business functional areas; industrial espionage; solving ethical problems; governance mechanism.

Suggested Readings

Gulshan SS & Kapoor GK. 2003. *Business Law including Company Law*. 10th Ed. New Age Publ.

Kapoor ND. 2005. *Business Law*. S. Chand & Sons.

Tulsain PC. 2006 *Business Law*. Tata McGraw Hill.

Tuteja SK. 2005. *Business Law for Managers*. S. Chand & Sons.

ABM/MGT 506 HUMAN RESOURCE MANAGEMENT 2+0

Objective

The objective of this course is to expose the learner to the field of human resource management. The focus will be on human resource practices and their utility for managers.

Contents

UNIT-I: Introduction to Human Resources Management; Human Resource Planning-Nature and Significance, Job Analysis, Job Description, job Specification, Job enlargement, Job enrichment, Job rotation, Job evaluation.

UNIT-II: Recruitment and Selection Process, Induction, Training and Human Resource Development-Nature, Significance, Process and Techniques, Internal mobility including Transfers, Promotions, employee separation.

UNIT-III: Performance Appraisal ï Significance and methods, Compensation management, Wage and Salary Administration - Course Objective; Wage Fixation; Fringe Benefits, Incentive Payment, bonus, and Profit Sharing.

UNIT-IV: Industrial Relations-Role and Status of Trade Unions; Collective Bargaining; Workerôs Participation in Management, Career planning and employee retention.

UNIT-V: Quality of work life, employee welfare measure, Disputes and grievance Handling Procedures; Arbitration and Adjudication; Health and Safety of Human Resources; Human Resources accounting, Human Resources outsourcing.

Suggested Readings

Ashwathapa K. 1997. *Human Resource Management*. Tata McGraw.

Flippo EB. 1984. *Personnel, Management*. McGraw-Hill.

Garry D. 2001. *Human Resource Management*. 7th Ed. Prentice-Hall of India.

Mamoria CB. 1996. *Personnel Management*. Himalaya Publ. House.

Subba Rao P. 2004. *Essentials of Human Resource Management and Industrial Relations*. Himalaya Publ. House.

Venkantavatnam CS & Srivastav BK. 1991. *Personnel Management and Human Resources*. Tata McGraw-Hill.

ABM/MGT 507 BUSINESS MATHEMATICS AND STATISTICS 2+0

Objective

The objective of this course is to acquaint the learner with the basic concepts of mathematics and statistics used for business decisions. Focus will be on understanding the application of these techniques in solving business problems.

Contents

UNIT-I: Simple Differentiation and Integration, Maxima and Minima; Use of Determinants and Matrices in business decisions and solving linear equations

UNIT-II: Different approaches to probability, addition and multiplication rules, marginal probability, conditional probability, Bayes Theorem, probability distributions; mathematical expectations; point estimation and interval estimation for population mean and proportions

UNIT-III: Frequency Distribution, Measures of Central Tendency, Measures of Variation, Skewness and Kurtosis.

UNIT-IV: Simple, partial, and multiple correlations, rank correlation, simple and multiple regression, introduction to Forecasting Methods (Qualitative and Quantitative).

UNIT-V: Hypothesis testing, Null Hypothesis, Level of Significance, One Tail and Two Tail Tests, Type I and Type II Errors, t-Test, F-Test, Z-test, Chi-Square Test, Run Test, Sign Test.

Suggested Readings

Gupta SP. 1992. *Statistical Method*. S. Chand & Sons.

Sancheti DC & Kapoor VK. 1995. *Business Mathematics*. S. Chand & Sons.

Srivastava UK, Shenoy GV & Sharma SC. 1998. *Quantitative Techniques for Managerial Decisions*. AITBS Publ.

ABM/MGT 508 INTRODUCTION TO AGRIBUSINESS MANAGEMENT 2+0

Objective

To acquaint the students regarding the basic concept of agribusiness, agribusiness organizations, value addition, agri-input markets, etc.

Contents

UNIT-I: Role of agriculture in Indian economy: Agri-Business ï Definition, Nature, Scope and Prospects; Types of Agribusiness;

UNIT-II: Emerging trends in production and changing dimensions of Agri-business in India, Unique features of agri-products in comparison to non- agri-products; Buffer Stock; Procurement and working of Public Distribution System

UNIT-III: Agri-Business Organizations ï Working and Functioning of Selected Organizations such as Food Corporation of India, Cotton Corporation of India, NAFED, National Bank for Agriculture and Rural Development, Warehousing Corporations etc.

UNIT-IV: Agri-inputs- Seeds, Fertilizers, Agricultural Machinery, Pesticides etc. - delivery system and channels in marketing.

UNIT-V: Emerging trends in processing of agricultural output: Degrees of Processing, and Advantages of Processing; Location Factors for Agro Industry, Problems in Processing and suggestions for Improving Efficiency.

Suggested Readings

Acharya SS & Agarwal NL. *Agricultural Marketing in India*. 4th Ed. Oxford & IBH.

Broadway AC & Broadway Arif A. *A Text Book of Agri-Business Management*. Kalyani.

Duft Kenneth D. *Principles of Management in Agri-business*. Reston Publ. Co.

Erickson Steven P, Akridge Jay T, Barnard Freddie L, Downey W Davidg & Ray A. *Agribusiness Management*. 3rd Ed. McGraw-Hill.

Singh Sukhpal. 2004. *Rural Marketing*. Vikash Publ. House.

ABM/MGT 509 MARKETING MANAGEMENT 3+0

Objective

The objective of this course is to develop an understanding of the field of marketing. The focus will be on imparting knowledge of the basic concepts, tools, and functions of marketing.

Contents

UNIT-I: The Concept of Marketing Management; Marketing Environment; Marketing Mix, Strategic Marketing, Market Segmentation, Targeting, and Positioning; Buyer Behavior, Marketing Information System, Marketing Organization and Control

UNIT-II: Marketing potential and forecasting, Classification of Products; Product Life Cycle; New Product Development; Product Line and Product Mix; Branding, Packaging and labeling.

UNIT-III: Factors affecting prices; Pricing Policies and Strategies; Pricing Methods.

UNIT-IV: Types of Distribution Channels; Functions of Channel Members; Channel Management Decisions.

UNIT-V: Promotion Mix; Introduction to Advertising, Personal Selling, Sales Promotion, Publicity and Public Relations. and Direct marketing, managing integrated marketing promotion, Customer Relationship Management.

Suggested Readings

Brassington 1997. *Marketing Management.* Pitman Publ. House.

Kotler P. 2002. *Marketing Management – Analysis, Planning, Implementation and Control*. Pearson Edu.

McCarthy 2003. *Marketing Management*. Tata McGraw Hill.

Saxena R. 2002. *Marketing Management*. Mc Graw Hill.

Stanton WJ, Etzel MJ & Walker BJ. 1996. *Fundamentals of Marketing*. McGraw Hill.

ABM/MGT 510 FINANCIAL MANAGEMENT 2+0

Objective

The course aims to make students proficient in concepts and techniques of financial management. Focus will be on developing understanding of the application of Financial and investment decisions.

Contents

UNIT-I: Introduction to Financial Management**,** Its meaning and functions, Interface of financial management with other functional areas of a business.

UNIT-II: Capital Structure, Determinants of size and composition of Capital Structure, Capital Structure Theories; Long term financing and Cost of Capital.

UNIT-III: Working Capital Management, Determinants of Size and Composition of Working Capital, Cash and receivables management, inventory management; Working Capital Management Theories, Financing of Working Capital.

UNIT-IV: Financial planning and Forecasting, Financial planning for mergers & acquisition, Capital Budgeting**,** Undiscounted and Discounted cash flow methods of Investment Appraisal; Hybrid finance and lease finance.

UNIT-V: Business Financing System in India, Money and Capital Markets, Regional and All - India Financial Institutions; venture capital financing and its stages, micro finance and International financial management.

Suggested Readings

Chandra P. 2000. *Financial Management*. Tata McGraw Hill.

Khan MY & Jain PK. 2004. *Financial Management: Text, Problems and Cases*. Tata McGraw Hill.

Pandey IM. 1997. *Financial Management*. Vikas Publ.

Ramachandran N & Kakani RK. 2005. *Financial Accounting for Management*. Tata McGraw Hill.

Van Horne JC. 1997. *Financial Management and Policy*. Prentice Hall.

ABM/MGT 511 PRODUCTION AND OPERATIONS MANAGEMENT 2+0

Objective

The objective of this course is to expose the learner to the field of production and operations management. The focus will be on imparting knowledge of the basic concepts, tools, and functions of production management.

Contents

UNIT-I: Nature and Scope of Production and Operations Management; Its relationship with Other Systems in the Organization; Factors Affecting System and Concept of Production and Operation Management; Facility location, Types of Manufacturing Systems and Layouts, Layout Planning and Analysis.

UNIT-II: Productivity Variables and Productivity Measurement, Production Planning and Control, Mass Production, Batch Production, Job Order Manufacturing, Product Selection, Product Design and Development, Process Selection, Capacity planning.

UNIT-III: Scheduling, Maintenance Management Concepts, Work Study, Method Study, Work Measurement, Work Sampling, Work Environment, Industrial Safety.

UNIT-IV: An Overview of Material Management, Determination of Material Requirement, Purchase Management, Store Management, Logistics management, Material Planning and Inventory management, JIT, Safety Management.

UNIT-V: Quality Assurance, Accepting Sampling, Statistical Process Control, Total Quality Management, ISO standards and their Importance, Introduction to re-engineering, value engineering.

Suggested Readings

Adam & Ebert. 2006. *Production and Operations Management: Concepts, Models and Behaviour.* 5th Ed. Prentice Hall of India.

Buffa ES. 2008. *Modern Production/Operations Management*. Wiley India.

Stevenson WJ. 2005. *Operations Management*. Tata McGraw Hill.

ABM/MGT 512 RESEARCH METHODOLOGY 3+0

Objective

The objective of this course is to develop an understanding of research methodology. The focus will be on process and techniques of research.

Contents

UNIT-I: Role and uses of quantitative techniques in analysis and decision making; Meaning, types, and process of research; research methodology in management-exploratory, descriptive, experimental, diagnostic, Problem formulation, formulation of hypotheses.

UNIT-II: Scales of measurement - nominal, ordinal, interval, ratio, Likert scale and other scales; Primary and secondary data, sources of data, instruments of data collection, data editing, classification, coding, validation, tabulation, presentation, analysis.

UNIT-III: Concept of Sampling, Probability and non-probability sampling techniques including Simple Random Sampling, Stratified Sampling, Multi-stage Sampling, Systematic Sampling, Purposive Sampling, Quota sampling, judgment sampling, and convenience sampling, sample size determination, sampling and non-sampling errors.

UNIT-IV: ANOVA- one way and two way classification, Randomized Block Design and Latin Square Design; Index Numbers.

UNIT-V: Discriminant and dummy variable analysis; Factor analysis, cluster analysis, conjoint analysis, multi-dimensional analysis etc,; Report writing: Types of report, essentials and contents of good report writing.

Suggested Readings

Cooper DR & Schindler PS. 2006. *Marketing Research Concepts and Cases*. Tata McGraw Hill.

Green PE, Tull DS & Albaum G. 1998. *Research for Marketing Decisions*. Prentice Hall of India.

Kothari CR. 1989. *Research Methodology*. Wiley Eastern.

Wilkinson & Bhandarker 1989. *Research Methods in Social Sciences*. Himalaya Publ. House.

ABM/MGT 513 OPERATIONS RESEARCH METHODS 2+0

Objective

The objective of this course is to acquaint the learner with the applications of some important Operations Research techniques. Focus will be on understanding the use of these techniques in solving business problems.

Contents

UNIT-I: Linear Programming: Objective, Assumptions, Formulation of Linear Programming Problem, Graphic Method, Simplex method, Transportation and Assignment Problems.

UNIT-II: Inventory control Models: Costs Involved in Inventory Management, Types of Inventory, Economic Order Quantity (EOQ) Model, Continuous Review (Q) System, Periodic Review (P) System.

UNIT-III: Waiting Line Models: Waiting Line Problem, Characteristics of a Waiting-Line System, Single- Channel Model, Multiple-Channel Model, Constant-Service Time Model, Finite Population Model, Sequencing and Replacement models.

UNIT-IV: Decision making under Risk and uncertainties, Decision problems, Maximax Criterion, Maximin Criterion, Minimax Regret Criterion, Laplace Criterion, Pay off Tables, Decision Trees, Expected Value of perfect Information.

UNIT-V: Game Theory - Two -Person Zero-Sum Game, Simulation, Network analysis ï PERT & CPM.

Suggested Readings

Cook TM & Russell RA. 1989. *Introduction to Management Science*. Prentice Hall.
Taha HA. 2005. *Operations Research - An Introduction*. Prentice Hall.
Vohra ND. 2006. *Quantitative Techniques in Management*. McGraw Hill.
Wagner HM. 2005. *Principles of Operation Research*. Prentice Hall.

ABM/MGT 514 PROJECT MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT 2+0

Objective

The objective of this course is to expose the learner to the fields of project management and entrepreneurship development. Focus will be to train the students to develop new projects and encouraging them to start their own ventures.

Contents

UNIT-I: Concept, characteristics of projects, types of projects, project identification, and Projectôs life cycle.

UNIT-II: Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.

UNIT-III: Project scheduling and resource allocation; Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Pay back period, Project implementation; Cost over run, Project control and information system.

UNIT-IV: Entrepreneurship, Significance of entrepreneurship in economic development, qualities and functions of entrepreneur, entrepreneurship development programs and role of various institutions in developing entrepreneurship,

UNIT-V: Life cycles of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, Developing effective business plans, Procedural steps in setting up of an industry.

Suggested Readings

Chandra P. 2005. *Project Management*. Tata McGraw Hill.
Gopal Krishan P & Nagarajan K. 2005. *Project Management*. New Age.
Hisrich RD & Peters MP. 2002. *Entrepreneurship*. Tata McGraw Hill.
Kaplan JM. 2003. *Patterns of Entrepreneurship*. John Wiley & Sons.
Nandan H. 2007. *Fundamentals of Entrepreneurship Management*. Prentice Hall.
Ramamoorthy VE. 2005. *Textbook of Project Management*. Mac Millan.

ABM/MGT 515 MANAGEMENT INFORMATION SYSTEMS 2+0

Objective

The objective of this course is to develop an understanding and utility of MIS. The focus will be on imparting knowledge of the basic concepts, development, functions and usage of MIS.

Contents

UNIT-I: The concept of MIS ï Definition, importance, Course Objective, pre-requisites, advantages and challenges; Information Needs of organization, MIS and Decision ï Making.

UNIT-II: Types/Classification of Information System for organizations - Office Automation Systems, Transaction Processing Systems, Decision Support System, Executive Support System, Knowledge Based Expert System.

UNIT-III: Applications of MIS in the areas of Human Resource Management, Financial Management, Production/Operations Management, Materials Management, Marketing Management.

UNIT-IV: Development of MIS for an organization – The concept and stages of System Development Life Cycle.

UNIT-V: Information Technology– concept, applications, advantages and pre-requisites, Choice of Information Technology, Social and Legal Dimension of IT.

Suggested Readings

James OôBrien 1999. *Management Information System*. Tata McGraw Hill.
Lauden & Lauden. 2003. *Management Information System*. Pearson Edu.

ELECTIVES
Agribusiness Management

ABM 516 RURAL MARKETING 2+0

Objective

To objective of this course is to develop understanding regarding issues in rural markets like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

Contents

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

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

UNIT-III: Rural consumerôs behaviour - behavior of rural consumers and farmers; buyer characteristics and buying behaviour; Rural v/s urban markets, customer relationship management, rural market research.

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 Course Objective, pricing policy and pricing strategy, distribution strategy.

UNIT-V: Promotion and communication strategy - Media planning, planning of distribution channels, and organizing personal selling in rural market in India, innovation in rural marketing.

Suggested Readings

Krishnamacharyulu C & Ramakrishan L. 2002. *Rural Marketing*. Pearson Edu.

Ramaswamy VS & Nanakumari S. 2006. *Marketing Management*. 3rd Ed. MacMillan Publ.

Singh AK & Pandey S. 2005. *Rural Marketing*. New Age.

Singh Sukhpal. 2004. *Rural Marketing*. Vikas Publ. House.

ABM 517 AGRICULTURAL MARKETING MANAGEMENT 2+0

Objective

The objective of this course is to give the students an understanding of concept, various policies, strategies and decisions relating to marketing that can be developed by agribusiness firms.

Contents

UNIT-I: Meaning and scope, agricultural marketing and economic development; Agricultural market structure ï meaning, components and dynamics of market structure; marketing strategy ï meaning & significance, formulation of marketing strategy; agribusiness marketing environment, design of marketing mix, market segmentation and targeting, determinants of consumerôs behaviour.

UNIT-II: Product management - product management process and decisions, new product development ï significance and classification of new product, stages and estimation of demand of new product; product life cycle.

UNIT-III: Pricing policies and practice for agribusiness - determinants of price, objectives of pricing policies and pricing methods.

UNIT-IV: Promotional management - advertising planning and execution; sales promotion; grading and standardization.

UNIT-V: Distribution management - storage and warehousing, and transportation management for agricultural products; marketing agencies/intermediaries ï roles and functions; distribution channels involved in agribusiness.

Suggested Readings

Acharya SS & Agarwal NL. 2004. *Agricultural Marketing in India*. 4th Ed. Oxford & IBH.

Kohls RL & Uhj JN. 2005. *Marketing of Agricultural Products*. 9th Ed. Prentice Hall.

Kotler P. 2002. *Marketing Management – Analysis, Planning, Implementation and Control*. Pearson Edu.

Krishnamacharyulu C & Ramakrishan L. 2002. *Rural Marketing*. Pearson Edu.

Ramaswamy VS & Nanakumari S. 2002. *Marketing Management*. 2nd Ed. Mac Millan India.

ABM 518 FOOD TECHNOLOGY AND PROCESSING MANAGEMENT 2+0

(To be taught by Food Science & Technology)

Objective

The objective of this course is to acquaint the students with different food processing techniques and their management.

Contents

UNIT-I: Present status of food industry in India; Introduction to unit operations of food industry; Deteriorative factors and hazards during processing, storage, handling and distribution. Supply chain management

UNIT-II: Elements of food processing & preservations by manipulation of various parameters. Application of heat, radiations, chemicals and microbes and enzymes.

UNIT-I: Handling and processing of fruits and vegetables, milk & milk products, egg, poultry, fish, meat, cereals, pulses, nuts & oilseeds etc.Packaging of foods.

UNIT-IV: Risk management; Laws and regulations related to food industry, food production and marketing; Quality management systems, National & International quality standards, PFA, ISO, Codex etc.

UNIT-V: Case studies on project formulation in various types of food industries-milk and dairy products, fruits and vegetables, cereal and pulse milling, bakery and confectionery, oil and fat processing, honey production etc.

Suggested Readings

Acharya SS & Aggarwal NL. 2004. *Agricultural Marketing in India*. Oxford & IBH.
Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Blackie.
Jelen P. 1985. *Introduction to Food Processing*. Reston Publishing.
Potly VH & Mulky MJ. 1993. *Food Processing*. Oxford & IBH.
Selected articles from journals.

ABM 519 FERTILIZER TECHNOLOGY AND MANAGEMENT 2+0

(To be taught by Soil Science)

Objective

The objective of this course is to acquaint the students in latest advances in fertilizer technology management.

Contents

UNIT-I: Fertilizer development ï concept, scope, need, resource availability; types of fertilizers, grading and chemical constituents, role of fertilizers in agricultural production, production and consumption of fertilizer in India.

UNIT-II: Raw material needed and principles of manufacturing of nitrogenous, phosphatic and potassic fertilizers, sources of secondary nutrient and micro-nutrient.

UNIT-III: Quality control and legal aspects- fertilizer control order.

UNIT-IV: Testing facilities; constraints in fertilizer use and emerging scenario of fertilizer use; fertilizer distribution, fertilizer storage.

UNIT-V: Field trials and demonstration, scope of bio-fertilizer; environmental pollution due to fertilizer use.

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
Fertilizer Control Order (different years). Fertilizer Association of India, New Delhi.
Fertilizer Statistics (different years). Fertilizer Association of India, New Delhi.
Indian Journal of Fertilizers (different years). Fertilizer Association of India, New Delhi.
San Chilli V. 1960. *Chemistry and Technology of Fertilizers*. American Chemical Soc. Monograph Series. Reinhold Publ. Corp.
Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 2002. *Soil Fertility and Fertilizers*. 5th Ed. Prentice Hall.

ABM 520 MANAGEMENT OF AGRO CHEMICAL INDUSTRY 2+0

(To be taught by Entomology, Plant Pathology and Agronomy)

Objective

To familiarize the students with the agrochemicals, their structure, classification and development and also how to manage the agro-chemical industries.

Contents

UNIT-I: Agro-chemicals: Definition and classification; Basic knowledge of agro-chemicals; role and status of agro-chemical industry in India; Herbicides ï Classification and Introduction, knowledge of different pesticides.

UNIT-II: Insecticides ï Definition and classification based on (a) Mode of Entry (b) Mode of Action and (c) Chemical Structure; preliminary knowledge of mode of action of insecticides; knowledge of plant protection equipments.

UNIT-III: Fungicides ï Classification and preliminary knowledge of commonly used fungicides; Biomagnifications of pesticides and pesticidal pollution.

UNIT-IV: Introductory knowledge about development of agro-chemicals; Insecticidal poisoning, symptoms and treatment; Main features of Insecticide Act.

UNIT-V: Directorate of Plant Protection, Quarantine and Storage ï A brief account of its organizational set up and functions; IPM Concept ï Bio-pesticides ï Plant products.

Suggested Readings

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani.

Hayes WT & Laws ET. 1991. *Hand Book of Pesticides*. Academic Press.

Matsumura F. 1985. *Toxicology of Insecticides*. 2nd Ed. Plenum Publ.

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM*. Aditya Books.

ABM 521 FARM BUSINESS MANAGEMENT 2+0

Objective

To acquaint the students with the basic principles of farm management dealing with the analysis of farm resources having alternatives within the framework of resource restrictions.

Contents

UNIT-I: Nature, scope, characteristics and role of farm business management; farm management decisions; farm management problems.

UNIT-II: Principles of farm management decisions ï principle of variable proportion, cost principle, principle of factor substitution, law of equi-marginal returns, opportunity cost principle, etc.

UNIT-III: Tools of farm management and farm business analysis - farm planning and budgeting; Farm records and accounts, types and problems in farm records and accounts, net worth statement, farm efficiency measures.

UNIT-IV: Management of farm resources ï Land, Labour, Farm machinery, Farm building, etc.

UNIT-V: Risk and uncertainty in farming -sources of uncertainty in farming, management strategy to counteract uncertainty and decision making process in farm business management under risks and uncertainty.

Suggested Readings

Heady EO & Jensen H. 1960. *Farm Management Economics*. Prentice Hall.

Johl SS & Kapoor TR. 1973. *Fundamentals of Farm Business Management*. Kalyani Publ.

Kahlon AS & Singh K. 1992. *Economics of Farm Management in India*. Allied Publ.

Panda SC. 2007. *Farm Management and Agricultural Marketing*. Kalyani Publ.

ABM 522 SEED PRODUCTION TECHNOLOGY AND MANAGEMENT 2+0

(To be taught by Seed Science and Technology)

Objective

To apprise students regarding principles and efficient management of seed production technology.

Contents

UNIT-I: Seed Technology ï Role of Seed Technology, Seed Industry in India, National Seed Corporation ï Tarai Seed Development Corporation, State Seed Corporations, National Seed Project and State Farms and their role.

UNIT-II: Development and Management of Seed Programmes ï Seed Village Concept, Basic Strategy of Seed Production and Planning and Organization of Seed Programme; Types of Seed Programme ï Nucleus seed, Breeders seed, Foundation seed and Certified seed etc.

UNIT-III: Maintenance of genetic purity ï Minimum seed certification standard and Management of breeders & Nucleus seed; Management of seed testing laboratory and research and development.

UNIT-IV: Management of seed processing plant, seed storage management; seed packaging and handling.

UNIT-V: Statutory intervention in the seed industry; Seed legislation and seed law enforcement, Seed act; Orientation and visit to seed production farms, seed processing Units, NSC, HSDC, etc.

Suggested Readings

Agarwal AK. 1993. *Handbook of Seed Testing*. DOAC, Ministry of Agriculture, Govt. of India.

Agrawal RL. 1997. *Seed Technology*. Oxford & IBH.

Desai BB, Katecha PM & Salunkhe DK. 1997. *Seed Handbook: Biology, Production, Processing and Storage*. Marcel Dekker.

Joshi AK & Singh BD. 2004. *Seed Science and Technology*. Kalyani Publ.

Kelly A. 1988. *Seed Production of Agricultural Crops*. Longman.

McDonald MB Jr. & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.

ABM 523 TECHNOLOGY MANAGEMENT FOR LIVESTOCK PRODUCTS 2+0

(To be taught by Livestock Products Technology)

Objective

To impart knowledge about management of livestock products, product development, quality control, preservation and marketing strategies for livestock products.

Contents

UNIT-I: Present status of livestock products industry in India ï dairy, meat poultry, skin, wool, etc; Dairy Products- Manufacturing technologies of various dairy products and by-product utilization.

UNIT-II: Meat and Poultry Products- Manufacturing technologies of meat and meat products, egg and poultry products; production processing and utilization of wool and animal by-products.

UNIT-III: Plant Management- Production planning and control needs and techniques of production control, packaging, preservation and storage system for livestock products; transportation system for domestic markets and international markets.

UNIT-IV: Quality control measures during storage and transit; extent of losses during storage and transport, management measures to minimize the loss.

UNIT-V: Marketing and distribution of animal products; quality standard for various products; environmental and legal issues involved.

Suggested Readings

Forrest JC. 1975. *Principles of Meat Science*. Freeman Publ.

Gracey 1999. *Thorntons Meat Hygiene*. WB Saunders.

Mountney GJ. *Poultry Products Technology*. 2nd Ed. AVI Publ.

Ockerman & Hansen. 2002. *Animal Byproducts Processing and Utilization*. CRC Publ.

Pearson AM & Gillett TA. 1996. *Processed Meat*. 3rd Ed. Chapman & Hall.

Robertson GL. 1993. *Food Packaging Principles and Practices*. Marcel Dekker.

Stadelman W & Cotterill OJ. 2002. *Eggs Science and Technology*. 4th Ed. CBS Publ.

Sukumar De 1980. *Outlines of Dairy Technology*. Oxford Univ. Press.

Walstra et al. 2006. *Dairy Science and Technology*. 2nd Ed. Taylor & Francis Publ.

Yadav. 1993. *Comprehensive Dairy Microbiology*. Metropolitan Publ.

ABM 524 FRUIT PRODUCTION AND POST HARVEST MANAGEMENT 2+0

(To be taught by Fruit Science)

Objective

To impart knowledge regarding agro-techniques of fruit crops and their post-harvest management.

Contents

UNIT-I: World production and horticulture in India; present status of fruit industry in India and emerging scenario.

UNIT-II: Management of horticultural crops ï establishing an orchard, basic cultural practices, regulation of flowering, fruiting and thinning, protection against insect-pest, weeds: pre and post harvest management for quality and shelf life.

UNIT-III: Post harvest management in horticulture- procurement management, important factors for marketing, standardization and quality control, packaging.

UNIT-IV: Development of dehydrated products from some important fruits, storage of pulp in pouches, essential oils from fruit waste, dehydrated fruits. Market structure and export potential of fruits.

UNIT-V: Problems in marketing of fruits, and government policy; quality standards for domestic and international trade.

Suggested Readings

Chadha KL & Pareek OP. 1993. *Advances in Horticulture*. Vols. I-IV. Malhotra Publ. House.

Kader AA. 1992. *Post-harvest Technology of Horticultural Crops*. Univ. of California. Div. of Agri. & Natural Resources.

ABM 525 FARM POWER & MACHINERY MANAGEMENT 2+0

(To be taught by Farm Machinery and Power Engineering)

Objective

To acquaint the students with the farm mechanization status in the country and various techniques for farm machinery management and marketing.

Contents

UNIT-I: Various sources of farm power, their availability and utilization; Course Objective, importance and present status, level and the scope of farm mechanization.

UNIT-II: Tractor and power tillage industry ï model, make, capacity, production, present status and future prospects; concept of zero tillage.

UNIT-III: Farm machinery selection for different size of farm size and for different agro-climatic conditions; scheduling of farm operations for higher efficiencies, indices of machine performance.

UNIT-IV: Cost analysis of operations using different implements, economic performance of machines, optimization of tractor implements system and transport of farm produce.

UNIT-V: Agricultural equipments industry ï their production, marketing and constraints; establishment of agricultural engineering enterprises.

Suggested Readings

Carville LA. 1980. *Selecting Farm Machinery*. Louisiana Coop. Extn. Service Publ.

FAO 1984. *Agricultural Engineering in Development: Selection of Mechanization*. Agric. Service Bull.

Hunt D. 1977. *Farm Power and Machinery Management*. Iowa State Univ. Press.

Waters WK. 1980. *Farm Machinery Management Guide*. Pennsylvania Agric. Extn. Service Spl. Circular No. 1992.

ABM 526 INTERNATIONAL TRADE AND SUSTAINABILITY GOVERNANCE 2+0

Objective

To impart knowledge to the students of international trade in agriculture and various provisions under WTO in the new trade regime.

Contents

UNIT-I: International trade ï basic concepts, WTO and its implications for Indian economy in general and agriculture sector in particular.

UNIT-II: TRIPS, TRIMS quotas, anti dumping duties, quantitative and qualitative restrictions, tariff and non-tariff measures, trade liberalization, subsidies, green and red boxes, issues for negotiations in future in WTO; CDMs and carbon trade.

UNIT-III: Importance of foreign trade for developing economy; absolute and comparative advantage, foreign trade of India.

UNIT-IV: Composition of Indiaôs foreign trade policy; Indiaôs balance of payments; inter regional Vs international trade; tariffs and trade control; exchange rate; the foreign trade multiplier.

UNIT-V: Market entry methods, export procedures & documentations.

Suggestive Readings

Chadha GK. 2003. *WTO and Indian Economy*. Deep & Deep.

Economic Survey of India. Ministry of Finance, Govt. of India. (various issues)

HAU 2003. *Refresher Course on Technological Interventions to Face WTO Challenges*. AAREM & HRD CCS HAU Hisar.

Indian Journal of Agricultural Economics

Vasisht AK & Singh Alka. 2003. *WTO and New International Trade Regime- Implication for Indian Agriculture*. Advance Publ. Concept.

ABM 527 MANAGEMENT OF AGRIBUSINESS COOPERATIVES 2+0

Objective

To provide the students an understanding about the agribusiness cooperative organizations and their management.

Contents

UNIT-I: Cooperative administration- a global perspective, ecology of cooperative administration, cooperative sector and economic development.

UNIT-II: Cooperative management- nature, functions and purpose of cooperatives ï procurement, storage, processing, marketing, process of cooperative formation, role of leadership in cooperative management.

UNIT-III: The state and cooperative movement, effects of cooperative law in management, long range planning for cooperative expansion, policy making.

UNIT-IV: Human resource management, placement and role of board of directors in cooperative management.

UNIT-V: Overview of agribusiness cooperative ï credit cooperatives, cooperative marketing, dairy cooperative; financing agribusiness cooperatives.

Suggested Readings

Akmat JS. 1978. *New Dimensions of Cooperative Management*. Himalaya Publ. House.

Ansari AA. 1990. *Cooperative Management Patterns*. Anmol Publ.

Sah AK. 1984. *Professional Management for the Cooperatives*. Vikas Publ. House.

ABM 528 AGRIBUSINESS FINANCIAL MANAGEMENT 2+0

Objective

To impart trainings to the students regarding various aspects of financial management for agribusiness.

Contents

UNIT-I: Importance, need and scope of financial management; classification and credit need in changing agriculture scenario; finance functions, investment and dividend functions; balance sheet, income statement, cash flow statement for a agribusiness unit.

UNIT-II: Financial planning and control ï assessment of financial requirement of a agribusiness unit; leverage ï concept of leverage, financial and operating leverage; factor affecting capital structure, features of an optimal capital structure.

UNIT-III: Working capital management ï concept and components of working capital, need for working capital in agribusiness, management of cash and accounts receivables, and inventory management for agribusiness.

UNIT-IV: Capital budgeting - steps and concept of capital budgeting, appraisal criteria ï payback period, average rate of return, net present value, benefit-cost ratio and internal rate of return.

UNIT-V: Agri-business financing system in India - functioning of cooperative credit institutions, commercial banks, regional rural banks, NABARD, Agro-Industries Corporation, etc in agribusiness financing.

Suggested Readings

Chandra P. 2000. *Financial Management*. Tata McGraw Hill.

Khan MY & Jain PK. 2004. *Management Accounting*. Tata McGraw Hill.

Nelson AG & Murrey WG. 1988. *Agricultural Finance*. Kalyani Publ.

Pandey IM. 1997. *Financial Management*. Vikas Publ. House.

ABM 529 FOOD RETAIL MANAGEMENT 2+0

Objective

The objective of this course is to assist students in understanding the structure and working of food marketing system in India, to examine how the system affects farmers, consumers and middlemen and to illustrate the response of this dynamic marketing system to technological, socio-cultural, political and economic forces over time.

Contents

UNIT-I: Retail management and Food Retailing, Organized Retailing in India, E-tailing and Understanding food preference of Indian Consumers, Food consumption and Expenditure pattern, Demographic and Psychographic factors affecting Food Pattern of Indian Consumer.

UNIT-II: Value Chain in Food Retailing**,** Principal trends in food wholesaling and retailing, the changing nature of food stores, various retailing formats, value chain and value additions across the chain in food retail.

UNIT-III: 4 Pôs in Food Retail Management**,** Brand Management in Retailing, Merchandise pricing, Pricing Strategies used in food retailing, Promotion mix for food retailing, Management of sales promotion and Publicity, Advertisement Strategies for food retailers.

UNIT-IV: Managing Retail Operations**,** Managing Retailersô Finances, Merchandise buying and handling, Merchandise Pricing, Logistics, procurement of Food products and Handling, Transportation of Food Products.

UNIT-V: Types of Retail Selling, Salesperson selection, Salesperson training, Evaluation and Monitoring, Customer Relationship Management, Managing Human Resources in retailing

Suggested Readings

Berman & Evans. 2008. *Retail Management: A Strategic Approach*. 10th Ed. Prentice Hall of India.

Cox. 2006. *Retailing: An Introduction*. 5th Ed. Pearson Edu.

Levy M. & Weitz BW. 2004. *Retailing Management*. 5th Ed. McGraw Hill.

ABM 530 MANAGEMENT OF AGRICULTURAL INPUT MARKETING 2+0

Objective

The objective of this course is to give the students an understanding of different marketing concept and marketing system in context of agricultural inputs.

Contents

UNIT-I: Agricultural input marketing ï meaning and importance; Management of distribution channels for agricultural input marketing; Agricultural Inputs and their types ï farm and non-farm, role of cooperative, public and private sectors in agri- input marketing.

UNIT-II: Seed- Importance of seed input; Types of seeds- hybrid, high yielding and quality seeds; Demand and supply of seeds; Seed marketing channels, pricing, export-import of seeds; Role of NSC and State Seed Corporations.

UNIT-III: Chemical Fertilizers- Production, export-import, supply of chemical fertilizers, Demand/consumption, Prices and pricing policy; subsidy on fertilizers; marketing system ï marketing channels, problems in distribution; Role of IFFCO and KRIBCO in fertilizer marketing.

UNIT-IV: Plant Protection Chemicals- Production, export/import, consumption, marketing system ï marketing channels; Electricity/Diesel Oil- marketing and distribution system; pricing of electricity for agriculture use; subsidy on electricity.

UNIT-V: Farm Machinery- Production, supply, demand, Marketing and distribution channels of farm machines; Agro-industries Corporation and marketing of farm machines/implements.

Suggested Readings

Acharya SS & Agarwal NL. 2004. *Agricultural Marketing in India*. 4th Ed. Oxford & IBH.

Broadway AC & Broadway Arif A. 2003. *A Text Book of Agri-Business Management*. Kalyani.

Singh AK & Pandey S. 2005. *Rural Marketing*. New Age.

Singh Sukhpal. 2004. *Rural Marketing- Focus on Agricultural Inputs*. Vikas Publ.

ABM 531 FEED BUSINESS MANAGEMENT 2+0

(To be taught by Animal Nutrition)

Objective

To acquaint the students with the role and importance of feed industry and the production of feed for livestock and poultry.

Contents

UNIT-I: Present status of feed resources; gap between demand and availability of nutrients; status of feed industry in India and world, constraints in the development of Indian feed industry.

UNIT-II: Nutrients requirements of livestock and poultry; feed stuff and their origin; scientific storage of feeds and feed ingredients; protection of protein and fat.

UNIT-III: Processing of feeds, layout and design of feed plants, feed plant management; feed preparation for fish and pet animals, specialty feeds.

UNIT-IV*:* Importance and preparation of mineral mixture; feed additives and supplements, feed mixing, principles of mixing and compounding of feeds; improving the feeding value of poor quality roughages.

UNIT-V: Distribution channels, regulations relating to manufacture and sale of feed stuffs.

Suggested Readings

Gohl BO. 1981. *Tropical Feeds*. FAO.

McEllihnery Robert R. 1994. *Feed Manufacturing Technology*. American Feed Industry Assoc.

Pfost Harry B. 1976. *Feed Manufacturing Technology*. American Feed Industry Assoc.

Rajgopalan K. *Feed Industry Red Book*. ZMAG Publ.

Rajgopalan K. 1989. *Storage Structures*. Oxford & IBH.

ABM 532 AGRI SUPPLY CHAIN MANAGEMENT 2+0

Objective

The course introduces students to the concepts and processes of agricultural supply chain management, framework for structuring supply chain drivers; network designs, demand forecasting, inventory planning, sourcing decisions and IT enablement of supply chain.

Contents

UNIT-I: Supply Chain Management ï Concept, need, and significance; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM.

UNIT-II: Demand Management in Supply Chain**:** Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain.

UNIT-III: Procurement Management in Agri. Supply chain: Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification of Purchases Goods or Services, Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory (VMI).

UNIT-IV: Logistics Management: Elements of Logistics ; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management ; Fleet Management ; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL)

UNIT-V: Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; Performance Measurement and Controls in Agri. Supply Chain Management**-** Benchmarking: introduction, concept and forms of Benchmarking.

Suggested Readings

Altekar RV. 2006. *Supply Chain Management: Concepts and Cases*. Prentice Hall of India.

Monczka R, Trent R & Handfield R. 2002. *Purchasing and Supply Chain Management*. Thomson Asia.

Van Weele AJ. 2000. *Purchasing and Supply Chain Management Analysis, Planning and Practice*. Vikas Publ.

ABM 533 POULTRY AND HATCHERY MANAGEMENT 2+0

(To be taught by Livestock Production Management)

Objective

The course provides an insight into the importance of management in poultry industry, managing a poultry and hatchery enterprise, planning production of poultry products, financial, personnel and marketing management.

Contents

UNIT-I: Poultry and hatchery industry; role of management in poultry industry.

UNIT-II: Planning and establishing a poultry and hatchery unit- location, size and construction; farm and hatchery equipments and physical facilities; organizing and managing a poultry farm and hatchery.

UNIT-III: Incubation and hatching; production of quality chicks and eggs; factors affecting hatchability; bio-security and hatchery sanitation; handling of hatching eggs; maintaining chick quality-chick grading, sexing, packing, dispatch , transportation and chick delivery.

UNIT-IV: Franchise hatcheries; custom hatching; brooding; growing and laying management; industrial breeding, feeding, housing and disease management; waste management; Record management; cost accounting and budgetary control.

UNIT-V: Risks and insurance; personal management- labour relations including wages and salaries, job evaluation and employee appraisal; marketing management-direct sale and sale through franchisees/ agents, advertisement, sale and after sale services, other innovative sales strategies.

Suggested Readings

Card LE. *Poultry Production.*

North. *Commercial Chicken Production Manual.*

Singh RA. *Poultry Production.*

Winter AR. & Funk EM. *Poultry Science and Practices.*

ABM 534 MANAGEMENT OF FLORICULTURE AND LANDSCAPING 2+0

(To be taught by Floriculture and Landscape Architecture)

Objective

To objective of this course is to expose the students with floriculture technology and its Agri business implications including international trade.

Contents

UNIT-I: Introduction, importance and scope of floriculture industry; Recent advances in floriculture industry.

UNIT-II: Drying and dehydration of flowers; response of flowers to environmental conditions; importance and scope of landscape gardening.

UNIT-III: Style of gardening, Anesthetic and Socio-aesthetic planning of old and newly developed towns and cities; commercial cultivation of flower crops (rose, jasmine gladiolus, tuberose, marigold, aster, carnation, gerbera, cilium chrysanthemum; use of plant regulators in flower production.

UNIT-IV: Extraction, purification and storage of essential oils and perfumes; post harvest changes in cut flowers, storage and packing of cut flowers; determining optimum time of harvesting of flowers for export and home use.

Suggested Readings

Chadha KL & Choudhary B. *Ornamental Horticulture in India*. ICAR.

Grindal EW. *Every Day Gardening in India*. D.B. Tarporevala Sons.

Randhawa GS & Mukhopadhyay A. *Floriculture in India*. Allied Publ.

Randhawa MS. *Beautifying India*. Raj Kamal Publ.

ABM 535/ FST 533 BUSINESS MANAGEMENT & INTERNATIONAL TRADE 3+0

Objective

To acquaint the students with concepts, areas, functions and techniques of Business Management & International Trade in the context of food sector.

Contents

UNIT-I: The concept of business, trade, industry, firm and management; functions of management; areas of management; concept and functions of marketing; scope of

marketing management; marketing mix; marketing organizational structure; micro and macro environments; consumer behaviour; consumerism; marketing research and marketing information systems.

UNIT-II: Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning; Allocation of marketing resources; Marketing Planning Process; Product policy and planning; Product-mix; product line; product life cycle; New product development process; Branding, packaging, services decisions; Marketing channel decisions: Retailing, wholesaling and distribution; Pricing Decisions: Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry.

UNIT-III: Promotion mix decisions, Advertising: functions, objectives, and types; advertising budget and advertising message; Media Planning; Personal Selling; Publicity; Sales Promotion; Food and Dairy Products Marketing.

UNIT-IV: International Marketing and International Trade; Salient features of International Marketing; Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports-Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process; Deciding marketing Programme; Product, Promotion, Price, Distribution Channels; Deciding the Market Organization; World Trade Organization (WTO).

Suggested Readings

Cateora Philip R & Graham John L. 2001. *International Marketing*. 10th Ed. Tata McGraw Hill.

Keegan WJ. 1996. *Global Marketing Management*. 5th Ed. Prentice Hall of India.

Kotler Philip. *Marketing Management – Analysis, Planning.*

Terpstra Vern & Sarathy Ravi. 1997. *International Marketing*. 7th Ed. The Dryden Press.

MBA (General)

FINANCE

MGT 516 WORKING CAPITAL MANAGEMENT 2+0

Objective

To impart knowledge about the concept, importance and management of working capital in an organization.

Contents

UNIT-I: Working Capital Management: Concept of Working Capital Management, Liquidity Vs Profitability trade off, Decision towards optimum working capital, Calculation of operating working capital

UNIT-II: Management of Cash: objective of cash management, Motives for holding cash, Preparation of the cash budget, Managing the cash flows, Reasons for investing in marketable securities.

UNIT-III: Management of Account Receivables: Optimum credit policy, Terms of credit, Credit procedures for individual accounts, Credit analysis and Credit control. Factoring services and its types.

UNIT-IV: Inventory Management: Benefits of holding inventory, Inventory management techniques, Inventory control techniques.

UNIT-V: Working Capital Financing: Short term credit; Trade credit, Bank loan, Commercial paper, Secured loans, Recommendations of Dahejia Committee, Tandon Committee and Chore Committee Report.

Suggested Readings

Krish Rangarajan & Anil Mishra. *Working Capital Management*. Excel Books.

Rajesh Kothari & Bobby Dutta. *Contemporary Financial Management*. MacMillan India.

Ravi M Kishore. *Financial Management*. 6th Ed. Taxmann.

MGT 517 DIRECT TAX LAWS 2+0

Objective

To impart knowledge about the concept, importance and calculation of direct tax.

Contents

UNIT-I: Concept of Previous Year, Assessment Year, Income, Total Income, Gross Total Income,

UNIT-II: Tax Planning, Tax Evasion and Tax Avoidance, capital and Revenue Receipts/Expenditures, Exempted Income.

UNIT-III: Residential Status and incidence of Tax: Heads of Income-Salary, House Property, Business, Profession; Capital Gains and Other Sources

UNIT-IV: Set off and Carry forward of Losses; Deductions for individuals, Assessment of Individuals.

UNIT-V: Procedure of Filing Tax Return, Payment of Advance Taxes, Tax Deduction at Source.

Suggested Readings

Girish Ahuja & Ravi Gupta. *Systematic Approach to Income Tax & Central Sales Tax*. Bharat Law House.

N Hariharan. *Income Tax: Law & Practice*. Tata McGraw Hill.

MGT 518 FINANCIAL INSTITUTIONS 2+0

Objective

To impart knowledge about the various financial institutions and their functioning.

Contents

UNIT-I: Commercial Banks: Definition, Services and Principles of commercial banks, Nationalization of commercial banks ï Objects, Achievements and Criticism, Changing profile of Indian banking

UNIT-II: Practical banking: accounts of customers, Cheques: requisites of cheques crossing and endorsement, refusal of cheque payment by bank, Relation Between Banker and Customer

UNIT-III: Nature of Primary Reserves-its Nature and Functions; Nature of Secondary Reserves ï factors influencing the Level of Secondary Reserves

UNIT-IV: Management of Loans: Characteristics, Principles and factors Influencing loan policy of a bank, Credit analysis, and Supervision of Loans. Management of Income ï Determination of income, Earning, structure of a bank, Problems in allocation of bank income, Factors influencing pattern of allocation of bank income;

UNIT-V: Financial Institutions: Functions and Objectives of IDBI, SFC, NABARD, ICICI, SIDBI, LIC, and UTI.

Suggested Readings

Bank Financial Management. Indian Institute of Banking and Finance Ed. 2004, Taxmann Publ. Ltd.

Jeff Madura. *Financial Institutions and Market*. 7th Ed. 2007, Thomson South Western.

Shekhar& Shekhar. *Banking Theory and Practice*. 18th Ed. 1999, Vikas Publ.

MGT 519 STOCK MARKET OPERATIONS 2+0

Objective

To impart knowledge about the functioning of Indian stock market in our financial system

Contents

UNIT-I: Financial System: Nature and role of financial system and financial markets.

UNIT-II: Money and capital markets, money market instruments: call money, treasury bills, certificate of deposit, commercial bills, trade bills; Capital market: Brief profile of NSE, BSE, and OTCEI. Functions and organization of stock exchange.

UNIT-III: Primary/Secondary Market: Role, Procedure of raising finance, SEBI-role and Constitution;

UNIT-IV: Grievances Concerning Stock Exchange Dealings and their Removal, Grievance Cells in Stock Exchange

UNIT-V: Mutual Funds: Introduction, types, SEBI guidelines for Mutual Funds in India, Suggestions to make more effective.

Suggested Readings

Avadhani VA. *Investment and Securities Market in India*. 4th Ed. Himalaya Publ.

Gopalsamy N. *Capital Market: The Indian Financial Scene*. MacMillan India.

Machiraju HR. *The Working of Stock Exchanges in India*. 2nd Ed. New Age International.

MGT 520 MERCHANT BANKING AND FINANCIAL SERVICES MANAGEMENT 2+0

Objective

To impart knowledge about the concept and functions of different financial services in different areas of finance

Contents

UNIT-I: Concept, Nature and Scope of Financial Services, Participants of Financial Service, introduction to financial market;

UNIT-II: Leasing and Hire Purchase: Introduction to Leasing, Types of Lease, Myths about Leasing, prospects of leasing industry. Meaning of Hire Purchase, Contents of Hire Purchase Agreement, difference between leasing and hire-purchase;

UNIT-III: Venture Capital: Introduction to Venture Capital, Investment Process, Stages of financing, Venture Capital Organizations, Exit Route of Venture Capital Present Scenario and Future Prospects of Venture Capital in India.

UNIT-IV: Factoring and Merchant Banking: Factoring: Meaning and Types of Factoring Arrangements; Merchant Bankers: Functions of Merchant Bankers, Mode of Raising Capital from primary market, Role of secondary market. Recent developments in the Indian primary market and secondary market,

UNIT-V: Credit Rating Agencies: Concept and Types of Credit Rating Agencies. SEBI: functions and role in settlement of investorsô problems.

Suggested Readings

Khan MY. *Financial Service.* 4th Ed. Tata McGraw Hill.

Pathak VB. *Indian Financial System*. 2nd print 2004. Pearson Edu.

Sasidharan & Mathew. *Financial Services and System*. 2008. Tata McGraw Hill.

MGT 521 SECURITY ANALYSIS & PORTFOLIO MANAGEMENT 2+0

Objective

To impart knowledge about the concept and different theories of investment and portfolio

Contents

UNIT-I: Introduction: Principles of investment- risk and return Decisions, financial Assets and their Investment Characteristics, Components of Investment Risk.

UNIT-II: Securities Analysis: Analysis for Equity Investment ï Fundamental Analysis, Company Level Analysis, Economy and Industry Analysis.

UNIT-III: Technical Analysis, Efficient Market Hypothesis.

UNIT-IV: Portfolio Theory traditional and modern portfolio theory Markowitz and Sharpe model for Portfolio construction.

UNIT-V: Capital Market Theory: CAPM, APT.

Suggested Readings

Bhalla VK. *Investment Management : Security Analysis And Portfolio Management*. 11th Ed. S.Chand & Co.

Fisher & Jordan. *Security Analysis And Portfolio Management*. 5th Ed. Prentice Hall of India.

Ranganatham & Madhumati. *Investment Analysis And Portfolio Management*. Pearson Edu.

MGT 522 INTERNATIONAL FINANCIAL MANAGEMENT 2+0

Objective

To impart knowledge about the International economic issues, financial flows, institutions and instruments.

Contents

UNIT-I: International Financial Environment: Finance Functions of International Business, International Economic Issues, International Financial Flows

UNIT-II: Balance of Payment Framework; Foreign Exchange Risk Management: Foreign Exchange Market and Instruments, Exchange Rate-Determination & Forecasting.

UNIT-III: International Working capital Management: International Cash Management, International Receivables and Inventory Management

UNIT-IV: International financial Institutions and Instruments: IBRD, IMF, IFC- their Objectives and functions.

UNIT-V: International Financial Instruments-Swaps, hedging, options, G.D.R., A.D.R.

Suggested Readings

Apte PG. *International Financial Management*. 5th Ed. Tata McGraw Hill.
Eun & Resnick. *International Financial Managemen.* 3rd Ed. Tata McGraw Hill.
Jain Peyrard & Yadav. *International Financial Management.* Mac Millan India.

MGT 523 MANAGEMENT CONTROL SYSTEM 2+0

Objective

To impart knowledge about the concept, importance and management of control system

Contents

UNIT-I: Meaning and concept of Management control, types of control: organization control, strategic control, formal versus informal control, process of control, Introduction to management control system, and prerequisites of an effective management control system;

UNIT-II: Delegation and decentralization of authority- reasons of delegation, forms of delegation, factors determining delegation,

UNIT-III: Profit centre: definition, role of a profit center, the concept and methods of transfer pricing; Investment centre: Profit vs investment centre, performance measurement of an investment center,

UNIT-IV: Budget and budgetary control-meaning and types of budgets, performance budgeting, zero based budgeting;

UNIT-V: Performance evaluation-concept and need criteria for performance evaluation, reporting of performance

Suggested Readings

Ghosh. *Management Control Systems*. PHI Learning.
Maciariello &Kirby. *Management Control Systems: Using Adaptive Systems to Attain Control*. 2nd Ed. PHI Learning.
Shekhar. *Management Control System*. McGraw Hill.

MARKETING MANAGEMENT

MGT 524 SALES MANAGEMENT 2+0

Objective

The objective of this course is to acquaint students with the techniques of managing sales force and sales task of the company.

Contents

UNIT-I: The Field of Sales Management, Objectives and Functions of Sales Management, Evolution of Professional Selling, Relationship of Marketing and Selling, Functions and Role of Sales Manager

UNIT-II: Organization structure for sales department, Estimating Manpower Requirements for Sales department, Devising Sales Territories, Routing and Scheduling of Sales Force

UNIT-III: Recruitment and Selection of sales force, Training and Development, Placement and Induction of sales force, Motivating Sales Force

UNIT-IV: Compensation and Promotion Policies for sales people, Performance Appraisal of sales force

UNIT-V: Sales Budget and Budgeting Procedure, Quota Setting and Administrating, Sales and Cost Analysis, Sales Records and Reporting System, Sales Meetings and Contests.

Suggested Readings

Anderson Hair & Bush. *Professional Sales Management*. McGraw Hill.
Churchill Ford & Walker. *Sales force Management – Planning, Implementation & Control*. Richard D Irwin Publ.
Cundiff Still & Govoni. *Sales Management – Decisions, Strategies & Cases*. Prentice Hall.
Lancaster & Jobber. *Selling & Sales Management*. MacMillan.
Manning & Reece. *Selling Today*. Pearson Edu.
Spiro Stanton & Rich. *Management of a Sales Force*. Tata McGraw Hill.

MGT 525 MARKETING RESEARCH 2+0

Objective

The objective of this course is to acquaint students with the tools and techniques of marketing research. The focus will be to impart practical knowledge of conducting marketing research right from selection of problem till analysis and interpretation of data.

Contents

UNIT-I: Marketing Research- Nature, Scope, Importance, Process, Types and Limitations, Marketing Research and Marketing Information System

UNIT-II: Research Design-Concept and Steps in Developing a Research Design; Types of Errors Affecting Research Design, Choosing a Research Design

UNIT-III: Concepts of Universe and Sample, Techniques of Sampling, Type of scales and their uses.

UNIT-IV: Methods and Instruments of Data Collections, Techniques for Data Analysis, Testing of Hypothesis

UNIT-V: Product Research, Sales Research, Advertising Research; Organization and Management of Marketing Research Department, Ethical Issues in Marketing Research.

Suggested Readings

David J Luck & Ronald S Rubin. *Marketing Research*. Prentice Hall.

Donald S Tull & Del S Hawkins. *Marketing Research – Measurement and Method*. Prentice Hall.

Harper W Boyd Jr., Ralph Westfall & Stanley F Stasch. *Marketing Research – Text and Cases*. Richard D. Irwin, Inc.

William G Zikmund. *Exploring Marketing Research*. Thomson South-Western Publ.

MGT 526 CONSUMER BEHAVIOUR 2+0

Objective

The objective of this course is to expose students to the concepts and factors that influence consumer behaviour.

Contents

UNIT-I: Consumer Behavior- Concept and Importance, Need to Study Consumer Behavior, Consumer Needs and Motivations, Perception, Personality and Attitudes, Learning, Consumer Attitude Formation and Change

UNIT-II: Group Dynamics, Consumer Reference Groups-family, Social Class, Influence of Culture on Consumer Behavior, Sub-Cultural Aspects of Consumer Behavior

UNIT-III: Consumer decision-making process, opinion leaders, diffusion of innovations, innovator as opinion leader; Different views of decision making-economic man, passive man, cognitive man, emotional man

UNIT-IV: Models of consumer decision-making like Howard Seth, Nicosia and Engel Blackwell models etc.

UNIT-V: Public policy and Consumer Protection, Consumerism and Role of Media.

Suggested Readings

Hawkins. 2008. *Consumer Behaviour: Building Marketing Strategy*. 9th Ed. McGraw Hill.

Louden & Della Bitta. 2008. *Consumer Behaviour: Concepts and Applications*. 4th Ed. Tata McGraw Hill.

Schiffman LG & Kanuk L. 2003. *Consumer Behaviour*. Pearson Edu.

MGT 527 INTERNATIONAL MAKETING 2+0

Objective

The objective of this course is to expose students to the concept, need, methods and significance of international marketing.

Contents

UNIT-I: International Marketing-Nature, Scope and Importance, International Marketing Tasks, Market Entry Methods

UNIT-II: International Marketing Environment, Influence of Culture and Sub Culture, Tariff & non-tariff barriers

UNIT-III: International Product Policy, Planning and Development of Products for Foreign Markets

UNIT-IV: Pricing in International Markets, Pricing Objectives, and Determination of Pricing Policies and Strategies

UNIT-V: Types of International Distribution Channels- Selecting and Managing Distribution Channels, International promotion, Developing the Promotion-Mix for foreign Markets.

Suggested Readings

Keegan WJ. 1996. *Global Marketing Management*. 5th Ed. Prentice Hall of India.

Onkvisit Sak & Shaw John J. 1993. *International Marketing: Analysis and Strateg*. Ist Ed. Merrill Publ.

Philip R Cateora & John L Graham. 2001. *International Marketing*. 10th Ed. Tata McGraw Hill.

Terpstra Vern & Sarathy Ravi. 1997. *International Marketing*. 7th Ed. The Dryden Press.

MGT 528 ADVERTISING MANAGEMENT 2+0

Objective

The objective of this course is to impart the knowledge of creating an advertisement and releasing it in media.

Contents

UNIT-I: Advertising-Concept, Scope, Objectives, Types and Functions, Role of Advertising in marketing Mix, Advertising Versus other Tools of Promotions

UNIT-II: Advertising Planning and Decision-Making, Setting Goals and Objectives, Advertising Appeals and Theme, Message Tactics- Attention and Communication

UNIT-III: Elements of a Copy, Process of Copy Writing, Creativity in Copy Writing, Layout of Copy

UNIT-IV: Copy Testing-Techniques; Media Strategy and media Choice, Scheduling and Timing Decisions for Advertising

UNIT-V: Organizational structure and functions of an advertising agency, social responsibility of advertising.

Suggested Readings

Arens Willam F. 2006. *Contemporary Advertising*. 10th Ed. Tata McGraw Hill.

Batra Rajeev, John G Myers & David A Aaker. 2003. *Adverlising* Management. 5th Ed. Prentice Hall of India.

Belch George E & Michael A Belch. 2003. *Adverlising and Promotion: An Integrated Marketing Communications Perspective*. 6th Ed. Tata McGraw Hill.

Clow Kenneth E. 2007. *Integrated Adverlising, Promotion and Marketing Communications.* Pearson Edu.

Wells William & John Burnet. 2003. *Advcrlising Principlcs and Practices*. 5th Ed. Pearson Edu.

MGT 529 RETAIL MANAGEMENT 2+0

Objective

The objective of this course is to expose students to the field of retailing. The focus will be to impart knowledge of setting up and running a retail business.

Contents

UNIT-I: Retailing-Definition, Role and Importance, Evolution of Retail Institutions, Types of Retailers, Challenges for Retail Managers

UNIT-II: Retail Strategy Formulation, Retailing Mix, Latest Trends in Retailing Store Development ï Financial Planning, Site Selection, Store Design, Store Organization, Store Layout, and Staffing

UNIT-III: Merchandising Planning, Merchandise Resources, Pricing, Distribution and Control, Retail Promotion-Advertising, Publicity and sales promotion, Retail Display

UNIT-IV: Introduction to Non-Store Retailing - Direct Mail, Catalogues, Tele-Marketing, Electronic Retailing, Kiosks, Franchising;

UNIT-V: Retail Credit and Customer Services, Relationship Marketing; Retail Security, Operations Control, Expenses and Performance Control, Retail Audit.

Suggested Readings

Berman & Evans. 2008. *Retail Management: A Strategic Approach*. 10th edition. Prentice Hall of India Pvt. Ltd.

Cox. 2006. *Retailing: An Introduction*. 5th Ed. Pearson Edu.

Gilbert, David. 2003. *Retail Marketing Management*. Pearson Edu.

Levy M. &, Weitz, B.W. 2004. *Retailing Management*. 5th Ed. McGraw Hill.

Larson, Carl M, Robert E, Wegand & John S. Wright, *Basic Retailing.* Prentice Hall.

MGT 530 PRODUCT MANAGEMENT 2+0

Objective

The objective of this course is to expose students to different facets of product and brand management.

Contents

UNIT-I: Concept and importance of product management, product management processes, Product portfolio

UNIT-II: Product line decisions, product life cycle, new product development

UNIT-III: Product positioning, positioning strategies, branding decisions, brand management, brand hierarchy

UNIT-IV: Brand personality, brand equity, measurement of brand equity, brand extensions

UNIT-V: Packaging and labeling decisions, launching the product, test marketing, Product failures.

Suggested Readings

Lehmann. *Product Management*. 4th Ed. McGraw Hill.
Majumdar. *Product Management in* India. PHI.
Mathur. *Brand Management*. MacMillan India.
Percy. *Strategic Brand Management*. Oxford University Press.

MGT 531 STRATEGIC MARKETING 2+0

Objective

The objective of this course is to impart knowledge of tools and techniques of strategic marketing to students

Contents

UNIT-I: Strategic marketing ï Concept, scope, and relevance, significance and challenges for strategic marketing.

UNIT-II: Strategic planning, SWOT analysis, BCG and GE matrix.

UNIT-III: Marketing strategies for market leaders, challengers, followers, and nichers

UNIT-IV: Segmentation and competitive advantage, Product differentiation, Targeting and brand positioning

UNIT-V: Competitive pricing; Competitive advertising, Role of sales promotion in competitive marketing, Competitive distribution.

Suggested Readings

Jauch LR, Gupta R & Glueck WF. 2008. *Business Policy & Strategic Management*. 7th Ed. Frank Brothers & Co.
Nag A. 2008. *Strategic Marketing*. 2nd Ed. Macmillan India.
Richard MS, Wilson Colin Gilligan & David J Pearson. 1998. *Strategic Marketing Management – Planning, Implementation, and Control*. Viva Books.
Walker. *Marketing Strategy: A Decision Focused Approach*. 5th Ed. Tata-McGraw Hill.

HUMAN RESOURCE MANAGEMENT

MGT 532 ORGANISATIONAL DEVELOPMENT AND INTERVENTION STRATEGIES 2+0

Objective

The objective of this course is to impart knowledge of the concept and techniques of organizational development and also to expose students to intervention strategies.

Contents

UNIT-I: Organisational development- history of organisational development, nature, characteristics, assumptions and process.

UNIT-II: Issues and challenges for OD practitioners-organisational value system, politics & OD, OD & strategic management, OD & quality movement.

UNIT-III: OD interventions-definition, types, person focused OD interventions, role focused interventions, personal, interpersonal and group interventions.

UNIT-IV: Comprehensive interventions, structural interventions, inter-group interventions, mirror interventions, process consultation.

UNIT-V: Transactional analysis, team building.

Suggested Readings

Allcorn. *Organisational Dynamics & Interventions*. PHI.

French. *Organisational Development and Transformation*. 6th Ed. McGraw Hill.

MGT 533 UNION MANAGEMENT RELATIONS 2+0

Objective

The objective of this course is to acquaint students with the intricacies of union management relations.

Contents

UNIT-I: Conceptual frame work- Concept, Scope and approaches to industrial relations, Evolution and current developments, Constitutional and Legal Framework of Industrial Relations

UNIT-II: Union and unionism- trade union development and functions, trade union structure and trade union recognition, leadership and management in the trade union, management and employersô association.

UNIT-III: Conflict resolution- dynamics of conflict and collaboration, nature and content of collective bargaining, negotiation skills, issues and trends in collective bargaining

UNIT-IV: Grievance Function in Industrial Relations, Role of labour conciliation, arbitration, and adjudication

UNIT-V: Workersô participation in management- evolution, structure and process, design and dynamics of participatory forms, strategies and planning for implementing participation.

Suggested Readings

Dwivdi. *Human Relations & Organisational Behaviour*. 5th Ed. Macmillan India.

Monappa A. *Industrial Relations*. McGraw Hill.

MGT 534 INDUSTRIAL PSYCHOLOGY 2+0

Objective

The objective of this course is to acquaint students with the concept and significance of Industrial psychology.

Contents

UNIT-I: Introduction to industrial psychology, historical background of industrial psychology in India

UNIT-II: Human performance and engineering psychology; The psychology of attitudes, frustration as a factor in behaviour, supervisory and executive leadership, motivation & work

UNIT-III: Personnel selection- occupational information, individual differences-techniques, interviews, psychological tests

UNIT-IV: Industrial accidents & their prevention- measures for safety

UNIT-V: Psychological factors in labour turnover, counseling, interviewing & improving job contents.

Suggested Readings

Cascio & Aguinis. *Applied Psychology in Human Resource Management*. 6th Ed. PHI.

Schultz. *Psychology & Work Today - An Introduction to Industrial & Organisational Psychology*. 8th Ed. Pearson Edu.

MGT 535 COMPENSATION MANAGEMENT 2+0

Objective

The objective of this course is to expose students to the concept and techniques of Compensation Management

Contents

UNIT-I: Compensation- compensation and rewards and their role in organisations, Economic and behavioural issues in compensation

UNIT-II: Constitutional and legal framework for wage legislation-constitutional framework and judicial norms of wage determination, international conventions and regulations, Law relating to Payment of Wages and Bonus, Regulation of Minimum Wages and Equal Remuneration

UNIT-III: Compensation structure and differentials- pay packet composition, wage determination, job evaluation, pay surveys

UNIT-IV: Reward system, incentives and pay restructuring- design of performance linked reward system, incentives for blue and white collars, bonus, profit sharing and stock options, allowances and benefits, pay restructuring in mergers, acquisitions and alliances

UNIT-V: Emerging issues and trends- compensation for executives and knowledge workers, tax planning, future trends in compensation management.

Suggested Readings

Goel. *Performance Appraisal & Compensation Management*. PHI.

Henderson. *Compensation Management in a Knowledge Based World*. 10th Ed. Pearson Edu.

Milkovich. *Compensation*. 8th Ed. McGraw Hill.

MGT 536 ORGANISATIONAL CHANGE AND STRESS MANAGEMENT 2+0

Objective

The objective of this course is to acquaint students with the concept and techniques of organizational change and also of stress management.

Contents

UNIT-I: Concept of managing change- Types of Change, factors critical to change, process of organisational change, key roles in organisational change, culture and change, managing resistance to change, effective implementation of change

UNIT-II: Forms of organizational change ï emerging organizational forms and structures, turn around management, mergers and acquisitions, process based change, group based approaches to change

UNIT-III: Diagnosis and intervention- issues and concept of organisational diagnosis, diagnostic methodology and methods (qualitative and quantitative), intervention in organisational change

UNIT-IV: Organisational change and process consultation- Key roles in managing change, skills for managing change, role of leadership in managing change, managing transiyion.

UNIT-V: Understanding stress- potential sources of stress, consequences of stress, managing stress, current models of stress management

Suggested Readings

Palmer. *Managing Organisational Change*. McGraw Hill.

MGT 537 LABOUR ECONOMICS 2+0

Objective

The objective of this course is to acquaint students with the concept and issues of labour economics.

Contents

UNIT-I: Introduction to labour market, Actors in labour market, labour supply, labour supply and business cycle, Industrial development and growth of labour.

UNIT-II: Economic analysis of labour markets, Demand and supply of labour, Public policy and labour issues

UNIT-III: Wages, compensation and job amenities, Wage structure, Piece rates and Time rates, Work incentives, Efficiency wages, Working condition of labour, Education and health issues.

UNIT-IV: Labour market discrimination, Race and gender discrimination, Employer discrimination, Issues related to women and child labour

UNIT-V: Labour migration, Immigratation to foreign countries, Issues of labour training and unemployment

Suggested Readings

Borjas GJ. *Labour Economics*. 3rd Ed. McGraw Hill.

Marshall. Carter & King. *Labour Economics – Wages, Employment & Trade Unionism*. Richard Irwin Publ.

MGT 538 INDUSTRIAL AND LABOUR LEGISLATION 2+0

Objective

The objective of this course is to expose students to various industrial and labour laws.

Content

UNIT-I: Introduction to labour legislation- philosophy of labour laws, classification of labour laws, International labour organization, international labour standards and Indian labour laws, Indian constitution and labour laws, labour policy.

UNIT-II: Laws on working conditions- the factories act-1948, the mines act-1952, contract labour regulation and abolition act-1970, child labour regulation and abolition act-1986.

UNIT-III: Industrial relation laws- trade union act-1926, industrial disputes act-1947, industrial employment standing orders act-1946.

UNIT-IV: Wage and labor laws- minimum wages act-1948, payment of wages act- 1936, payment of bonus act-1965, equal remuneration act-1976 .

UNIT-V: Laws of labour welfare and social security- workmenôs compensation act-1923, payment of gratuity act-1972, employeesô state insurance act-1948, maternity benefits act-1961, employeesô provident funds and miscellaneous provision act-1952.

Suggested Readings

Padhi. *Labour & Industrial Laws*. PHI.

MGT 539 STRATEGIC HUMAN RESOURCE MANAGEMENT 2+0

Objective

The objective of this course is to expose students to the concept and utility of strategic human resource management.

Contents

UNIT-I: Strategic role of human resource management- concept, nature & origin, linking organizational and HR strategies, strategic human resource in global context.

UNIT-II: Strategic staffing- strategic performance strategies, training and development strategies, international human resource management strategies.

UNIT-III: Organizational structuring and restructuring- new organizational forms and implications for strategic human resource management, employment relations in changing context.

UNIT-IV: HRM in Government and public systems, International experiences in HRM, Diversity Management, HRM Audit, Human resource accounting.

UNIT-V: Technology and HRM, Human Resource Information System, Knowledge Management.

Suggested Readings

Agarwala T. *Strategic Human Resource Management*. Oxford Univ. Press.

Dreher. *Human Resource Strategy*. McGraw Hill.

Prasad. *Strategic Human Resource Management- Text & Cases*. Macmillan Publ.

Schuler *Strategic Human Resource Management*. 2nd Ed. Wiley India.

List of Journals

- Agribusiness ï An International Journal
- Decision
- Harvard Business Review
- Indian Cooperative Review
- Indian Journal of Agricultural Economics
- Indian Journal of Agricultural Marketing
- Indian Journal of Finance
- Indian Journal of Marketing
- Indian Management
- Indian Management Studies Journal
- Journal of Agri-business
- Journal of Marketing Management
- Journal of Marketing Research
- Journal of Sales Management
- Management Review
- Prabandhan
- Vikalpa

e - Resources

- www.pearsoned.com (Pearson Education Publication)
- www.mcgraw-hill.com (McGraw – Hill Publishing Company)
- www.aima-ind.org (All India Management Association)
- www.oup.com (Oxford University Press)
- www.emeraldinsight.com (Emerald Group Publishing)
- www.sagepub.com (Sage Publications)
- www.harvardbusiness.com (Har ard Business Review)
- www.marketingpower.com (American: Marketing Association)
- www.isaeindia.org (Indian Society of Agricultural Economics)
- www.macmillanindia.com (Mac Millan Publishing)
- www.sfacindia.com (Small FarmersôAgri-Business Consortium)
- www.isapindia.org (Indian Society of Agribusiness Professionals)
- www.icar.org.in (Indian Council of Agricultural Research)
- www.nseindia.com (National Stock Exchange of India Ltd)
- www.nseindia.com (Bombay Stock Exchange)
- www.ncdex.com (National Commodity & Derivatives Exchange Limited)
- www.phdcci.in (PHD Chamber of Commerce and Industry)
- www.ficci.com (Federation of Indian Chambers of Commerce and Industry)
- www.assocham.org (Associated Chambers of Commerce and Industry of India)
- www.apeda.com (Agricultural and Processed Food Products Export Development Authority)
- www.mpeda.com (Marine Products Export Development Authority)

ENTOMOLOGY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
ENT 501*	INSECT MORPHOLOGY	1+1	I
ENT 502*	INSECT ANATOMY, PHYSIOLOGY AND NUTRITION	2+1	II
ENT 503/ ❶ NEMA 502	PRINCIPLES OF TAXONOMY	2+0	I
ENT 504*	CLASSIFICATION OF INSECTS	2+1	II
ENT 505*	INSECT ECOLOGY	1+1	I
ENT 506	INSECT PATHOLOGY	1+1	II
ENT 507*	BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS	1+1	I
ENT 508*	TOXICOLOGY OF INSECTICIDES	2+1	II
ENT 509	PLANT RESISTANCE TO INSECTS	1+1	I
ENT 510*/ ❷ NEMA 512	PRINCIPLES OF INTEGRATED PEST MANAGEMENT	1+1	I
ENT 511*#	PESTS OF FIELD CROPS	1+1	I
ENT 512*#	PESTS OF HORTICULTURAL AND PLANTATION CROPS	1+1	I
ENT 513	STORAGE ENTOMOLOGY	1+1	II
ENT 514/ ❸ PL PATH 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1	II
ENT 515	GENERAL ACAROLOGY	1+1	II
ENT 516	SOIL ARTHROPODS AND THEIR MANAGEMENT	1+1	I
ENT 517	VERTEBRATE PEST MANAGEMENT	1+1	I
ENT 518	TECHNIQUES IN PLANT PROTECTION	0+1	II
ENT 519	COMMERCIAL ENTOMOLOGY	1+1	I
ENT 520/ ❷ NEMA 514/ PL PATH 520	PLANT QUARANTINE	2+0	II
ENT 591	MASTERôS SEMINAR	1	
ENT 599	MASTERôS RESEARCH	20	
ENT 601	ADVANCED INSECT SYSTEMATICS	1+2	I
ENT 602	IMMATURE STAGES OF INSECTS	1+1	I
ENT 603	ADVANCED INSECT PHYSIOLOGY	2+0	I
ENT 604	ADVANCED INSECT ECOLOGY	1+1	II
ENT 605	INSECT BEHAVIOUR	1+1	I
ENT 606	RECENT TRENDS IN BIOLOGICAL CONTROL	2+0	II
ENT 607	ADVANCED INSECTICIDE TOXICOLOGY	2+1	I
ENT 608	ADVANCED HOST PLANT RESISTANCE	1+1	II
ENT 609	ADVANCED ACAROLOGY	1+1	I
ENT 610	AGRICULTURAL ORNITHOLOGY	1+1	II
ENT 611	MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH	1+1	II
ENT 612**	ADVANCED INTEGRATED PEST MANAGEMENT	2+0	II
ENT 613/ ❸ PL PATH 606$^{\$}$	PLANT BIOSECURITY AND BIOSAFETY	2+0	I
ENT 691	DOCTORAL SEMINAR 1	1	
ENT 692	DOCTORAL SEMINAR II	1	
ENT 699	DOCTORAL RESEARCH	45	

SERVICE COURSES			
SST 511	SEED ENTOMOLOGY	2+1	II
ABM 520	MANAGEMENT AGRICHEMICAL INDUSTRY	2+0	

*Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

#One out of 511 or 512 is compulsory

One course of Biochemistry or G&PB of 3 credits is compulsory as Minor/Supporting

To be taught by: ❶ Nematology; ❷ Entomology; ❸ Entomology and Plant Pathology

ENTOMOLOGY

Course Contents

ENT 501 INSECT MORPHOLOGY 1+1 SEM - I

Objective

To acquaint the students with external morphology of the insectôs 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 chemo-receptors).

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.

Suggested Readings

Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press.

David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*. Tata McGraw Hill.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ.

Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall.

Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance*. Agrotech Publ. Academy.

Snodgross RE. 1993. *Principles of Insect Morphology.* Cornell Univ. Press.

ENT 502 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION 2+1 SEM - II

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, sensory, reproductive, musculature, endocrine and exocrine glands.

UNIT-III: Thermodynamics; physiology of integument, 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 micro-organisms 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.

Suggested Readings

Chapman RF.1998. *Insects: Structure and Function*. ELBS Ed.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ.

Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology.* Vols. I-XIII. Pergamon Press.
Patnaik BD. 2002. *Physiology of Insects*. Dominant.
Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Vol. 1. *Structure, Physiology and Development.* Chapman & Hall.
Saxena RC & Srivastava RC. 2007. *Entomology at a Glance.* Agrotech Publ. Academy.
Wigglesworth VB.1984. *Insect Physiology.* 8th Ed. Chapman & Hall.

ENT 503/ NEMA 502 **PRINCIPLES OF TAXONOMY** **2+0** **SEM - I**

(To be taught by Nematology)

Objective

To sensitize the students on the theory and practice of classifying organisms and the rules governing the same.

Theory

UNIT-I: Introduction to history and principles of systematics and importance. Levels and functions of systematics. Identification, purpose, methods- character matrix, taxonomic keys. Descriptions- subjects of descriptions, characters, nature of characters, analogy vs homology, parallel vs convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

UNIT-II: Classification of animals: Schools of classification- Phenetics, Cladistics and Evolutionary classification. Components of Biological Classification: Hierarchy, Rank, Category and Taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories. Introduction to numerical, biological and cytogenetical taxonomy.

UNIT-III: 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.

Suggested Readings

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book.* John Wiley & Sons.
Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH.
Mayr E. 1971. *Principles of Systematic Zoology*. Tata McGraw Hill.
Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie.

ENT 504 **CLASSIFICATION OF INSECTS** **2+1** **SEM - II**

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

UNIT-II: Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota ï Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera ï 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-III: Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Division Neoptera ï Subdivision Endopterygota, Section Neuropteroid-Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid 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.

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers*. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press.

Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall.

Ross HH.1974. *Biological Systematics.* Addison Wesley Publ. Co.

Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects.* 7th Ed. Thomson/ Brooks/ Cole.

ENT 505 INSECT ECOLOGY 1+1 SEM - I

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 indicies. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

UNIT-I: History and Definition. Basic Concepts. Organisation of the Biological world. Platoôs Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. 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, Systems approach to ecology.

UNIT-II: Basic concepts of abundance- Model vs Real world. Population growth- basic models ï 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 - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche- ecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterraôs principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

UNIT-IV: Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, Mayôs *d/w*, Relation between the two and their association with Dyarôs Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology.

Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Hollingôs Disc equation, 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 niche breadth, activity breadth and diagramatic representation of niches of organisms. Calculation of some diversity indices- Shannonôs, Simpsonôs 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.

Suggested Readings

Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2nd Ed. Cambridge Univ. Press.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics.* Sinauer Associates.

Gotelli NJ. 2001. *A Primer of Ecology.* 3rd Ed. Sinauer Associates.

Gupta RK. 2004. *Advances in Insect Biodiversity*. Agrobios.

Krebs CJ. 1998. *Ecological Methodology*. 2nd Ed. Benjamin-Cummings Publ. Co.

Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance.* 5th Ed. Benjamin-Cummings Publ. Co.

Magurran AE. 1988. *Ecological Diversity and its Measurement.* Princeton Univ. Press.

Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley.

Real LA & Brown JH. (Eds). 1991. *Foundations of Ecology: Classic Papers with Commentaries*. University of Chicago Press.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Methuen & Co. Ltd.

Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ.

Wilson EO & William H Bossert WH. 1971. *A Primer of Population Biology*. Harvard University.

Wratten SD & Fry GLA.1980. *Field and Laboratory Exercises in Ecology*. Arnold.

ENT 506 INSECT PATHOLOGY 1+1 SEM - II

Objective

To teach the students about various microbes that are pathogenic to insects, factors that affect their virulence; provide hands-on training in identification, isolation, culturing various pathogens and assessing pathogenicity.

Theory

UNIT-I: History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT-II: Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT-III: Examples of successful instances of exploitation of pathogens for pest management and mass production techniques of pathogens. Safety and registration of microbial pesticides. Use of insect pathogens in integrated management of insect pests.

Practical

Familiarization with equipment used in insect pathology laboratory. Identification of different groups of insect pathogens and symptoms of infection. Isolation, culturing and testing pathogenicity of different groups of pathogens. Testing Kochôs postulates. Estimation of pathogen load. Extraction of pathogens from live organisms and soil. Bioassays to determine median lethal doses.

Suggested Readings

Boucias DG & Pendland JC. 1998. *Principles of Insect Pathology.* Kluwer.

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press.

Steinhaus EA. 1984. *Principles of Insect Pathology.* Academic Press.

ENT 507 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS 1+1 SEM - I

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.

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall.

Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall.

Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press.

Ignacimuthu SS & Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ.

Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ.

Van Driesche & Bellows TS. Jr. 1996. *Biological Control*. Chapman & Hall.

ENT 508 TOXICOLOGY OF INSECTICIDES 2+1 SEM - II

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 organo-chlorines, 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.

Suggested Readings

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.* Oxford & IBH.

Gupta HCL.1999. *Insecticides: Toxicology and Uses.* Agrotech Publ.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House.
Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ.

ENT 509 PLANT RESISTANCE TO INSECTS 1+1 SEM - I

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.

Suggested Readings

Dhaliwal GS & Singh R. (Eds). 2004. *Host Plant Resistance to Insects - Concepts and Applications.* Panima Publ.
Maxwell FG & Jennings PR. (Eds). 1980. *Breeding Plants Resistant to Insects.* John Wiley & Sons.
Painter RH.1951. *Insect Resistance in Crop Plants*. MacMillan.
Panda N & Khush GS. 1995. *Plant Resistance to Insects.* CABI.
Smith CM. 2005. *Plant Resistance to Arthropods – Molecular and Conventional Approaches.* Springer.

ENT 510/ NEMA 512 PRINCIPLES OF INTEGRATED PEST MANAGEMENT 1+1 SEM - I

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, biological, 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.
UNIT-IV: Components, classification,bases and mechanisms of host plant resistance; screening techniques, breeding methods including transgenics and importance of plant resistance in IPM.

Practical

Characterization of agro-ecosystems; demonstration of plant resistance in important crops; 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.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* 1st Ed., Springer.

Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer.

Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons.

Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker.

ENT 511 PESTS OF FIELD CROPS 1+1 SEM - I

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; study of life history of important insect pests.

Suggested Readings

Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology.* Popular Book Depot.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ.

Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ.

Evans JW. 2005. *Insect Pests and their Control.* Asiatic Publ.

Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR.

Prakash I & Mathur RP. 1987. *Management of Rodent Pests.* ICAR.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance.* Agrotech Publ. Academy.

ENT 512 PESTS OF HORTICULTURAL AND PLANTATION CROPS 1+1 SEM - I

Objective

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

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of 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, gherkin, drumstick, leafy vegetables etc.

UNIT-III: Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, 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.

Suggested Readings

Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publ.

Butani DK & Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essential of Agricultural Entomology.* Kalyani Publ.

Srivastava RP.1997. *Mango Insect Pest Management.* International Book Distr.

Verma LR, Verma AK & Goutham DC. 2004. *Pest Management in Horticulture Crops : Principles and Practices*. Asiatech Publ.

ENT 513 STORAGE ENTOMOLOGY 1+1 SEM - II

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, concepts of storage entomology and significance of insect pests. Post-harvest losses *in toto vis-à-vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses.

UNIT-II: Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

UNIT-III: 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 commoditiesô storage conditions.

UNIT-IV: Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites 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, IGSMRI, Hapur etc. (only where logistically feasible).

Suggesting Readings

Hall DW. 1970. *Handling and Storage of Food Grains in Tropical and Subtropical Areas.* FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.

Jayas DV, White NDG & Muir WE. 1995. *Stored Grain Ecosystem.* Marcel Dekker.

Khader V. 2004. *Textbook on Food Storage and Preservation*. Kalyani Publ.

Khare BP. 1994. *Stored Grain Pests and Their Management.* Kalyani Publ.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker.

ENT 514/ PL PATH 514 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS **1+1** **SEM - II**

(To be jointly taught by Entomology and Plant Pahology)

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, mealybugs 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.

Suggested Readings

Basu AN. 1995. *Bemisia tabaci* (Gennadius) - *Crop Pest and Principal Whitefly Vector of Plant Viruses.* Oxford & IBH.

Harris KF & Maramarosh K. (Eds.).1980. *Vectors of Plant Pathogens*. Academic Press.

Maramorosch K & Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents*. Academic Press.

Youdeovei A & Service MW. 1983. *Pest and Vector Management in the Tropics*. English Language Books Series, Longman.

ENT 515 GENERAL ACAROLOGY **1+1** **SEM - II**

Objective

To aquaint 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 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.

Suggested Readings

Chhillar BS, Gulati R & Bhatnagar P. 2007. *Agricultural Acarology*. Daya Publ. House.

Gerson U & Smiley RL. 1990. *Acarine Biocontrol Agents - An Illustrated Key and Manual*. Chapman & Hall.
Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India.
Gwilyn O & Evans GO. 1998. *Principles of Acarology*. CABI.
Jeppson LR, Keifer HH & Baker EW. 1975. *Mites Injurious to Economic Plants*. University of California Press, Berkeley.
Krantz GW. 1970. *A Manual of Acarology.* Oregon State Univ. Book Stores, Oregon.
Qiang Zhiang Z. 2003. *Mites of Green Houses- Identification, Biology and Control*. CABI.
Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House.
Walter DE & Proctor HC. 1999. *Mites- Ecology, Evolution and Behaviou*r. CABI.

ENT 516 SOIL ARTHROPODS AND THEIR MANAGEMENT 1+1 SEM - I

Objective

To impart knowledge about the different groups of arthropods found in soil, interaction between the different groups, and role of soil arthropods in humus formation. Hands-on training in sampling and identification of different groups of soil arthropods.

Theory

UNIT-I: Soil arthropods and their classification, habitats and their identification.

UNIT-II: Estimation of populations; sampling and extraction methods.

UNIT-III: Role of soil arthropods in detritus feeding, litter breakdown and humus formation. Soil arthropods as bio-indicators of habitat qualities. Effect of soil arthropod activity on soil properties.

UNIT-IV: Harmful and beneficial soil arthropods and their management, inter-relationship among arthropods and other soil invertebrates and soil microorganisms. Anthropogenic effects on soil arthropods.

Practical

Sampling, extraction methods and identification of various types of soil fauna; estimation and assessment of soil arthropod population; techniques and culturing soil invertebrates.

Suggested Readings

Anderson JM & Ingram JSI. 1993. *Tropical Soil Biology and Fertility: A Handbook of Methods.* CABI.
Dindal DL. 1990. *Soil Biology Guide*. A Wiley-InterScience Publ., John Wiley & Sons.
Pankhurst C, Dube B & Gupta, V. 1997. *Biological Indicators of Soil Health.* CSIRO, Australia.
Veeresh GK & Rajagopal D.1988. *Applied Soil Biology and Ecology*. Oxford & IBH.

ENT 517 VERTEBRATE PEST MANAGEMENT 1+1 SEM - I

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.

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 (LD_{50} 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.

Suggested Readings

Ali S. 1965. *The Book of Indian Birds*. The Bombay Natural History Society.
Fitzwater WD & Prakash I. 1989. *Handbook of Vertebrate Pest Control.* ICAR.
Prakash I & Ghosh PK.1997. *Rodents in Indian Agriculture*. Vol. I. State of Art Scientific Publ.
Prakash I & Ghosh RP.1987. *Management of Rodent Pests.* ICAR.
Prater SH. 1971. *The Book of Indian Animals*. The Bombay Natural History Society.

ENT 518 TECHNIQUES IN PLANT PROTECTION 0+1 SEM - II

Objective

To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopoy, 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 irradiation, fumigation, soil sterilization and bird scaring techniques.

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.

Suggested Readings

Alford DV. 1999. *A Textbook of Agricultural Entomology.* Blackwell Science.

Crampton JM & Eggleston P. 1992. *Insect Molecular Science.* Academic Press.

ENT 519 COMMERCIAL ENTOMOLOGY 1+1 SEM - I

Objective

To familiarize the students with entrepreneurial opportunities in entomology, provide information on productive insects and their products, as well as insect pests of public health and veterinary importance and their management.

Theory

UNIT-I: Apiculture-General colony management during different seasons. Managing colonies for honey production 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, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms. Lac insect- natural enemies and their management.

UNIT-III: Economic and public health importance of insect pests in human habitation and habitats, biology, damage and control of mosquitoes, houseflies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals and their management.

UNIT-IV: Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and post-construction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management.

Practical

Assessing pest status in dwellings (labs, canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches and rodents. Pre- and post-construction termite proofing methods, control of silverfishes in the library. Visit to poultry units and assessing pest status in poultries. Evaluation of commercially available domestic insect pest control products through bioassays. 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. Extraction and processing of hive products. Preparation of bee-keeping projects for funding. Visit to commercial apiaries. Silkworm rearing and management. Lac host and crop management technology and processing of lac. Products and bye-products of lac.

Suggested Readings

Aruga H. 1994. *Principles of Sericulture*. Oxford & IBH.

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

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

Partiban S & David BV. 2007. *Management of Household Pests and Public Health Pests*. Namratha Publ.

Singh S. 1975. *Beekeeping in India*. ICAR.

ENT 520/ NEMA 514/ PL PATH 520 **PLANT QUARANTINE** **2+0** **SEM - II**

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT-I: Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine ï domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT-II: Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT-III: Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT-IV: WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Suggested Readings

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM.* Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

ENT 601 **ADVANCED INSECT SYSTEMATICS** **1+2** **SEM - I**

(Pre-requisite ENT 503)

Objective

To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects. International Code of Zoological Nomenclature. Ethics and procedure for taxonomic publications.

Theory

UNIT-I: Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography.

UNIT-II: Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

UNIT-III: Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.

UNIT-IV: Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications - small publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.

Practical

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, construction of taxonomic keys for the selected group. Development of descriptions, photographing, writing diagrams, and preparation of specimens for ñtype likeò preservation. Submission of the collections made of the group. Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms.

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Dakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer-Verlag.

Freeman S & Herron JC. 1998. *Evolutionary Analysis.* Prentice Hall.

Hennig W. 1960. *Phylogenetic Systematics*. Urbana Univ. Illinois Press.
Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press.
Mayr E & Ashlock PD. 1991. *Principles of Systematic Zoology.* 2nd Ed. McGraw Hill.
Mayr E.1969. *Principles of Systematic Zoology.* McGraw-Hill.
Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy.* Blackie Academic and Professional.
Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co.
Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press.

ENT 602 IMMATURE STAGES OF INSECTS 1+1 SEM - I

Objective

To impart knowledge on morphology of immature stages of different groups of insects. Train students in identification of common pest species during their immature stages.

Theory

UNIT-I: Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects

UNIT-II: Comparative study of life history strategies in hemi-metabola and holo-metabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

Practical

Types of immature stages; their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.

Suggested Readings

Chu HF. 1992. *How to Know Immature Insects*. William Brown Publ., Iowa.
Peterson A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.
Stehr FW. 1998. *Immature Insects*. Vols. I, II. Kendall Hunt Publ., Iowa.

ENT 603 ADVANCED INSECT PHYSIOLOGY 2+0 SEM - I

(Pre-requisite ENT 502)

Objective

To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

Theory

UNIT-I: Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

UNIT-II: Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

UNIT-III: Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

UNIT-IV: Endocrine system and insect hormones, physiology of insect growth and development- metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

Suggested Readings

Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford.
Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology.* Assoc. for Advancement of Entomology, Trivandrum, India.

ENT 604 ADVANCED INSECT ECOLOGY 1+1 SEM - II

(Pre-requisite ENT 505)

Objective

To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects and the evolution of ecological characteristics.

Theory

UNIT-I: Characterisation of distribution of insects- Indices of Dispersion, Taylorôs Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

UNIT-II: Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses.

UNIT-III: Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

UNIT-IV: Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies - timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems ï Characterisation, Pest Control as applied ecology- case studies.

Practical

Methods of data collection under field conditions. Assessment of distribution parameters, Taylorôs power law, Iwaoôs patchiness index, Index of Dispersion, etc. Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods. Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies - Calculation of changes under selection, Demonstration of genetic drift. Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/*Goniozus*/Female Bruchids etc.- A test of reproductive effort and fitness. Construction of Life tables and application of Leslie Matrix ï population projections, Stable age distribution. Exercises in development of Algorithms for crop modeling.

Suggested Readings

Barbosa P & Letourneau DK. (Eds.). 1988. *Novel Aspects of Insect-Plant Interactions*. Wiley.

Elizabeth BA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects.* Chapman & Hall.

Freeman S & Herron JC.1998. *Evolutionary Analysis*. Prentice Hall.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed., Sinauer Associates, Sunderland, MA.

Krebs C. 1998. *Ecological Methodology.* 2nd Ed. Benjamin-Cummings Publ. Co.

Krebs CJ. 2001 *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co.

Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton University Press, Princeton.

Real LA & Brown JH. (Eds.). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Wiley Blackwell.

Strong DR, Lawton JH & Southwood R. 1984. *Insects on Plants: Community Patterns and Mechanism*. Harward University Press, Harward.

Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology*. Arnold Publ.

ENT 605 INSECT BEHAVIOUR 1+1 SEM - I
(Pre-requisite ENT 502)

Objective

To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behaviour in insects.

Theory

UNIT-I: Defining Behaviour- Concept of Umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

UNIT-II: Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

UNIT-III: Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self-organization and insect behaviour.

UNIT-IV: Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, co-evolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

Practical

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

Suggested Readings

Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford & IBH.

Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ.

Bernays EA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall.

Brown LB. 1999. *The Experimental Analysis of Insect Behaviour.* Springer.

Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology.* 3rd Ed. Chapman & Hall.

Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press.

Mathews RW & Mathews JR. 1978. *Insect Behaviour.* A Wiley-InterScience Publ. John Wiley & Sons.

ENT 606 RECENT TRENDS IN BIOLOGICAL CONTROL 2+0 SEM - II
(Pre-requisite ENT 507)

Objective

To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agro-ecosystems.

Theory

UNIT-I: Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.

UNIT-II: Mass culturing techniques, insectary facilities and equipments, basic standards

of insectary, viable mass-production unit, designs, precautions, good insectary practices.
UNIT-III: Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.
UNIT-IV: Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Suggested Readings

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press.
Coppel HC & James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag.
De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall.
Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ.
Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall.
Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press.

ENT 607 ADVANCED INSECTICIDE TOXICOLOGY 2+1 SEM - I

(Pre-requisite ENT 508)

Objective

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

Theory

UNIT-I: Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.
UNIT-II: Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural ï activity relationships; advances in metabolism of insecticides.
UNIT-III: Joint action of insecticides; activation, synergism and potentiation.
UNIT-IV: Problems associated with pesticide use in agriculture: pesticide resistance-resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.
UNIT-V: Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

Practical

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

Suggested Readings

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI.
Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ.
Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press.
Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House.
Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press.
Oô Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press.
Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House.
Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ.

ENT 608 ADVANCED HOST PLANT RESISTANCE 1+1 SEM - II

(Pre-requisite ENT 509)

Objective

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

Theory

UNIT-I: Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources ï behaviour in relation to host plant factors.

UNIT-II: Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance ï signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

UNIT-III: Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding.

UNIT-IV: Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Practical

Understanding mechanisms of resistance for orientation, feeding, oviposition *etc.*, allelochemical bases of insect resistance; macroculturing of test insects like aphids, leaf/plant hoppers, mites and stored grain pests; field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

Suggested Readings

Panda N. 1979. *Principles of Host Plant Resistance to Insects*. Allenheld, Osum & Co.

Rosenthal GA & Janzen DH. (Eds.). 1979. *Herbivores – their Interactions with Secondary Plant Metabolites*. Vol. I, II. Academic Press.

Sadasivam S & Thayumanavan B. 2003. *Molecular Host Plant Resistance to Pests*. Marcel Dekker.

Smith CM, Khan ZR & Pathak MD. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida.

ENT 609 ADVANCED ACAROLOGY 1+1 SEM - I

(Pre-requisite ENT 515)

Objective

To acquire a good working knowledge of identification of economically important groups of mites up to the species level, a detailed understanding of the newer acaricide molecules and utilization of predators.

Theory

UNIT-I: Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

UNIT-II: Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.

UNIT-III: Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.

UNIT-IV: Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

Practical

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens *etc.*

Suggested Readings

Evans GO.1992. *Principles of Acarology.* CABI.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents- An Illustrated Key and Manual*. Chapman & Hall.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State University Book Stores, Corvallis, Oregon.
Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House.

ENT 610 AGRICULTURAL ORNITHOLOGY 1+1 SEM - II

Objective

To expose the students to the prevalence of birds in agricultural fields, their habitat associations and the beneficial and harmful role played by birds in crop fields and management of pest situations.

Theory

UNIT-I: Status of agricultural ornithology in India, groups of birds associated with agro-ecosystems. Habitat associations of birds in both wet and dry agricultural systems. Association of birds with different cultivation practices and crop stages, their seasonality and succession. Pestiferous and beneficial birds associated with different crops, their general biology and ecology. Food and feeding habits of birds in crop fields.

UNIT-II: Nature of damage caused by birds in different crops. Foraging ecology of birds in agricultural fields. Birds affecting stored grains in houses and godowns. Beneficial role of birds in agriculture and attracting them to field. Use of bird excreta in agriculture. Management of bird pests in agriculture: physical, cultural, ecological and chemical methods.

Practical

Study of different groups of birds associated with agriculture, their morphology and field identification. Field visits to different agro-ecosystems. Study of bird associations with different crop stages. Study of nesting and roosting habits of birds in agricultural habitats. Study of the feeding habits, nature and types of damage caused by birds in selected crops. Visits to godowns. Analysis and study of the use of bird excreta in agriculture at a bird sanctuary. Field visits to paddy growing command areas to study birds in crop fields. Assignments on assessing bird damage, estimation of populations etc.

Suggested Readings

Dhindsa SR & Parasharya BM. 1998. *Birds in Agricultural Ecosystem.* Society for Applied Ornithology, Hyderabad.
Mehrotra KN & Bhatnagar RK. 1979. *Status of Economic Ornithology in India- Bird Depredents, Depredations and their Management.* ICAR.
Vasudeva Rao & Dubey OP. 2006. Grainivorous Pests and their Management. In: *Vertebrate Pests in Agriculture*, *The Indian Scenario* (Ed: Sridhara, S.), Scientific Publ.

ENT 611 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH 1+1 SEM - II

Objective

To familiarize the students with DNA recombitant techonology, marker genes, transgenic plants, biotechnology in sericulture and apiculture.

Theory

UNIT-I: Introduction to molecular biology; techniques used in molecular biology.

UNIT-II: DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

UNIT-III: Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, neuropeptides. Transgenic plants for pest resistance and diseases.

UNIT-IV: Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

UNIT-V: DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

Practical

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

Suggested Readings

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1st Ed., Kalyani Publ.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press.

Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests.* Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ.

Singh BD. 2008. *Biotechnology (Expanding Horizons)*. Kalyani Publ.

Singh P. 2007. *Introductory Biotechnology*. 2nd Ed. Kalyani Publ.

ENT 612 ADVANCED INTEGRATED PEST MANAGEMENT 2+0 SEM - II

(Pre-requisite ENT 510)

Objective

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

Theory

UNIT-I: Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

UNIT-II: Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

UNIT-III: Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmersô real-time situations.

UNIT-IV: Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer.

Koul O & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI.

Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management -Potential, Constraints and Challenges.* CABI.

Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall.

Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker.

ENT 613/ PL PATH 606 PLANT BIOSECURITY AND BIOSAFETY 2+0 SEM - I

(To be taught jointly by Entomology and Plant Pathology)

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT-I: History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT-II: National Regulatory Mechanism and International Agreements/ Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT-III: Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008. www.fao.org/docrep/010/a1140e/a1140e00.htm

Laboratory Biosecurity Guidance http://www.who.int/csr/resources/publications/ biosafety/ WHO_CDS_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan.* http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_ plan.pdf

Biosecurity Australia. www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia

Biosecurity New Zealand. www.biosecurity.govt.nz

DEFRA.www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns.* NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production. http://www.fao.org/biosecurity/

CFIA.http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtml

ENTOMOLOGY

List of Journals

- *Agricultural and Forest Entomology*- Royal Entomological Society, UK
- *Annual Review of Entomology*- Paloatto, California, USA
- *Applied Soil Ecology*- Elsevier Science, Amsterdam, The Netherlands
- *Biopesticides International*- Koul Research Foundation, Jalandhar
- *Bulletin of Entomological Research*- CAB International, Wallingford, UK
- *Bulletin of Grain Technology*- Food Grain Technologist Res. Association of India, Hapur
- *Crop Protection*- Elsevierôs Science, USA
- *Ecological Entomology* -Royal Entomological Society, UK
- *Entomologia Experimentalis Applicata*- Kluwer Academic Publishers, The Netherlands
- *Entomon*- Association for Advancement of Entomology, Kerala
- *Environmental Entomology*- Entomological Society of America, Maryland, USA
- *Indian Journal of Applied Entomology*- Entomological Research Association, Udaipur
- *Indian Journal of Entomology*- Entomological Society of India, New Delhi
- *Indian Journal of Plant Protection*- Plant Protection Society of India, Hyderabad
- *Indian Journal of Sericulture*- Central Silk Board, Bangalore
- *International Journal of Acarology*- Indira Acarology Publishing House, Minessota, USA
- *International Journal of Pest Management*- Taylor and Francis, UK
- *Journal of Acarology*- Acarological Society of India, UAS, Bangalore
- *Journal of Apiculture Research*- IBRA, UK
- *Journal of Applied Entomology*- Blackwell Science Ltd., Oxford, UK
- *Journal of Biocontrol*- Society for Biocontrol Advancement, Bangalore
- *Journal of Economic Entomology*- Entomological Society of America, Maryland, USA
- *Journal of Entomological Research*- Malhotra Publishing House, New Delhi
- *Journal of Insect Behaviour*- Plenum Publishing Corporation, NY, USA
- *Journal of Insect Physiology*- Pergamon Press, UK
- *Journal of Insect Science*- Indian Society for the Advancement of Insect Science, Ludhiana
- *Journal of Invertebrate Pathology*, Elsevier Publ. Corporation, The Netherlands
- *Journal of Soil Biology and Ecology,* Indian Society of Soil Biology and Ecology, UAS, Bangalore
- *Journal of Stored Products Research*- Elsevierôs Science, USA
- *Pesticide Biochemistry and Physiology*- New York, USA
- *Pesticide Science* ï Oxford, London
- *Pesticides Research Journal*- Society of Pesticides Science, New Delhi
- *Physiological Entomology*- Royal Entomological Society, UK
- *Review of Applied Entomology*- CAB International, Wallingford, UK
- *Systematic Entomology*- Royal Entomological Society, UK

e-Resources

- http://www.colostate.edu/Depts/Entomology/
- http://www.ent.iastate.edu/list/
- http://www.biologybrowser.org/
- http://www.teachers.ash.org.au/aussieed/insects.htm
- http://entomology.si.edu/
- http://www.intute.ac.uk/healthandlifesciences/agriculture/
- http://www.agriculture.gov.au/
- http://www.gbif.org/
- http://www.mosquito.org/
- http://www.nysaes.cornell.edu/fst/faculty/acree/pheronet/index.html
- http://medent.usyd.edu.au/links/links.htm
- http://www.ent.iastate.edu/list/
- http://www.ento.csiro.au/index.html
- http://www.biocollections.org/lib/listbycat.php?cat=Entomology

- http://www.IPMnet.org/DIR/
- http://www.nhm.ac.uk/hosted_sites/acarology/
- http://www.agnic.org/
- http://ars-genome.cornell.edu/
- http://www.tulane.edu/~dmsander/garryfavweb.html
- http://www.ufsia.ac.be/Arachnology/Arachnology.html
- http://www.ippc.orst.edu/IPMdefinitions/home.html
- http://www.ent.iastate.edu/list/
- http://www.ippc.orst.edu/cicp/pests/vertpest.htm
- http://ipmwww.ncsu.edu/cicp/IPMnet_NEWS/archives.html
- http://nematode.unl.edu/wormsite.htm
- http://www.bmckay.com/
- http://ace.ace.orst.edu/info/extoxnet/pips/pips.html
- http://www.ifgb.uni-hannover.de/extern/ppigb/ppigb.htm
- http://www.ceris.purdue.edu/npirs/npirs.html
- http://www.ces.ncsu.edu/depts/pp/bluemold/
- http://www.ipm.ucdavis.edu
- http://ippc.orst.edu/pestalert/
- http://www.orst.edu/Dept/IPPC/wea/
- http://www.barc.usda.gov/psi/bpdl/bpdl.html
- http://www.nalusda.gov/bic/BTTOX/bttoxin.htm
- http://www.nysaes.cornell.edu/ent/biocontrol/
- http://entweb.clemson.edu/cuentres/
- http://www.agr.gov.sk.ca/Docs/crops/cropguide00.asp
- http://www.caf.wvu.edu/kearneysville/wvufarm6.html
- http://www.chebucto.ns.ca/Environment/NHR/lepidoptera.html
- http://nt.ars-grin.gov/fungaldatabases/databaseframe.cfm
- http://www.orst.edu/dept/infonet/
- http://www.attra.org/attra-pub/fruitover.html
- http://www.ceris.purdue.edu/napis/pests/index.html
- http://danpatch.ecn.purdue.edu/~epados/farmstead/pest/src/
- http://ipmwww.ncsu.edu/current_ipm/otimages.html
- http://nematode.unl.edu/wormhome.htm
- http://www.ipm.ucdavis.edu/
- http://hammock.ifas.ufl.edu/en/en.html
- http://www.rce.rutgers.edu/weeddocuments/index.htm
- http://www.agric.wa.gov.au/ento/allied1.htm
- http://biology.anu.edu.au/Groups/MES/vide/refs.htm
- http://chrom.tutms.tut.ac.jp/JINNO/PESDATA/00database.html
- http://agrolink.moa.my/doa/english/croptech/crop.html
- http://nbo.icipe.org/agriculture/stemborers/default.html
- http://www.bdt.org.br
- http://www.bspp.org.uk/fbpp.htm
- http://www.elsevier.com/inca/publications/store/3/5/6/
- http://www.hbz-nrw.de/elsevier/00207322/
- http://ianrhome.uni.edu/distanceEd/entomology/401_801_insectphysio.shtml
- www.entsoc.org
- http://aprtc.org/
- http://www.ipmnet.org/news.html
- http://www.pestnet.org/
- www.fruitfly.org
- www.celera.com
- www.hgsc.bcm.tmc.edu/drosophila
- http://sdb.bio.purdue.edu/fly/aimain/links
- http://flybase.bio.indiana.edu/
- http://naasindia.org/journals.htm

Suggested Broad Topics for Master's and Doctoral Research

- Strengthening of eco-friendly strategies of integrated insect and mite pest management including:
    - Biological control
    - Bio-rational pesticides
    - Host plant resistance
    - Transgenic crop protection
    - Judicious use of pesticides
    - Molecular biosystematics
- Investigations on ecological factors including:
    - Survey and surveillance of insect and mite pests
    - Forecasting of insect and mite pest population life-tables and predictive models
    - Insect and mite biology
    - Population dynamics as influenced by abiotic and biotic factors
- Studies on role of pollination including honeybees in increasing crop yields and production of honey and other allied products and management of honeybee diseases and mites
- Pesticide resistance and Insecticide Resistance Management strategies
- Biotypes of pests
- Below ground biodiversity- Bio-indicator of soil health, role in decomposition of litter, soil physico-chemical properties
- Bioprospecting for protocols, peptides, genes, insecticidal proteins and antibiotics
- Climate change and pests
- IPM in protected cultivation
- Location specific IPM strategies in different cropping systems
- Genetic improvement of natural enemies
- Genetic improvement of silkworms
- Refinement of silkworm rearing technology for different regions
- Management of silkworm pests and diseases
- Crop-pest modeling
- Insect biochemistry- pheromones, hormones and neuropeptides
- Insect physiology- metabolism and regulatory mechanisms.
- Indigenous technology
- Plants as sources of insecticides
- Molecular systematics ï finger printing of species
- Insect systematics and phylogeny

EXTENSION EDUCATION & COMMUNICATION MANAGEMENT

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
EXT 501*	DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION	1+1	I
EXT 502*	DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT	2+1	I
EXT 503*	DIFFUSION AND ADOPTION OF INNOVATIONS	2+1	I
EXT 504*	RESEARCH METHODS IN BEHAVIORAL SCIENCES	2+1	II
EXT 505*	E-EXTENSION	2+1	II
EXT 506	ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION	2+1	II
EXT 507	HUMAN RESOURCE DEVELOPMENT	2+1	I
EXT 508	VISUAL COMMUNICATION	2+1	I
EXT 509	PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER	1+1	II
EXT 510	GENDER SENSITIZATION FOR DEVELOPMENT	2+1	II
EXT 511	PERSPECTIVES OF DISTANCE EDUCATION	1+1	II
EXT 591	MASTERôS SEMINAR	1	I, II
EXT 599	MASTERôS RESEARCH	20	I, II
EXT 601**	ADVANCES IN AGRICULTURAL EXTENSION	2+1	I
EXT 602**	ADVANCED DESIGN AND TECHNIQUES IN SOCIAL SCIENCE RESEARCH	2+1	I
EXT 603**	ADVANCES IN TRAINING TECHNOLOGY	2+1	II
EXT 604	ORGANIZATIONAL DEVELOPMENT	2+1	II
EXT 605	ADVANCED INSTRUCTIONAL TECHNOLOGY	2+1	I
EXT 606	COMPARATIVE EXTENSION	3+0	II
EXT 607	ADVERTISING AND MARKETING COMMUNICATION	1+1	I
EXT 608	MEDIA MANAGEMENT	2+1	I
EXT 609	TRANSFER OF TECHNOLOGY IN AGRICULTURE	2+1	II
EXT 691	DOCTORAL SEMINAR I	1	I, II
EXT 692	DOCTORAL SEMINAR II	1	I, II
EXT 699	DOCTORAL RESEARCH	45	I, II

* Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

The following courses are recommended for M. Sc. / Ph. D. programmes from supporting subjects

M. Sc.		
STAT 511	STATISTICAL METHODS FOR APPLIED SCIENCES	3+1
COMP 502	COMPUTER FUNDAMENTALS	2+1
Ph. D.		
STAT 513	SAMPLING TECHNIQUES	2+1
COMP 501	COMPUTER PROGRAMMING IN STATISTICAL RESEARCH	2+1

EXTENSION EDUCATION & COMMUNICATION MANAGEMENT

Course Contents

EXT 501 DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION 1+1 SEM - I

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 ï Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions ï Extension Education as a Profession ï Adult Education and Distance Education.

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

UNIT-III: Poverty Alleviation Programmes ï SGSY, SGRY, PMGSY, DPAP, DDP, CAPART ï Employment, Generation Programmes ï NREGP, Women Development Programmes ï 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 ï Led ï 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.

EXT 502 DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT 2+1 SEM - I

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 ï concept, elements and their characteristics ï Models and theories of communication ï Communication skillsï fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication ï Barriers in communication, Message ï Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

UNIT-II: Methods of communication ï Meaning and functions, classification. Forms of communication ï Oral and written communication, Non-verbal communication,

interpersonal communication, organizational communication. Key communicators ï Meaning, characteristics and their role in development.

UNIT-III: Media in communication ï Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media ï 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 ï 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

Basics of writing stories, feature articles, popular and scientific articles, farm bulletins and folders. Readability and comprehension testing procedures. Radio and TV jounalisms ï script writing, layout, design and editing. Communication drills to improve oral communication skills.

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.

EXT 503 DIFFUSION AND ADOPTION OF INNOVATIONS 2+1 SEM - I

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 ï 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 ï a critical appraisal of the new formulation.

UNIT-III: Adopter categories ï 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 ï Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions ï Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making ï meaning, theories, process, steps, factors influencing decision ï 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.

EXT 504 RESEARCH METHODS IN BEHAVIOURAL SCIENCES 2+1 SEM - II

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 ï Meaning, importance, characteristics. Behavioural sciences research ï Meaning, concept and problems in behavioural sciences research. Types and methods of Research ï Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature ï Need, Search Procedure, Sources of literature, Planning the review work. Research problem ï 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 ï Meaning, types and criteria for judging the objectives. Concept and Construct ï Meaning, role of concepts in research and Conceptual frame work development in research. Variable ï Meaning, types and their role in research. Definition ï Meaning, characteristics of workable definitions, types and their role in research. Hypothesis ï Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement ï 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 ï Meaning and methods of testing. Reliability ï Meaning and methods of testing. Sampling ï Universe, Sample and Sampling- Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors ï Methods of elimination and minimizing, Maximincon Principle, Sampling ï Types of sampling and sampling procedures.

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

UNIT-IV: Data processing ï 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 ï 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, Venkatapirabu 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.

EXT 505 E- EXTENSION 2+1 SEM - II

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.

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

EXT 506 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION 2+1 SEM - II

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 ï Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri ï entrepreneurship ï Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs ï Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise ï 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 ï Market, Technical, Financial, Social Appraisal of Projects.

UNIT-II: Micro enterprises ï Profitable Agri enterprises in India ï Agro Processing, KVIC industries. Micro financing ï meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises ï Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development ï Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises ï Issues relating to success and failure of enterprises ï Personal, Production, Finance, Social, Marketing.

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

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

EXT 507 HUMAN RESOURCE DEVELOPMENT 2+1 SEM - I

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 ï Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions ï 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 ï 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 ï 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 ï Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager ï Responsibility of Professional Manager; Managerial skills and Soft Stills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics :Leadership styles ï Group dynamics.

UNIT-III: Training ï Meaning, determining training need and development strategies ï Training types, models, methods and evaluation; Facilities for training ï Trainers training ï techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate ï organizing for HRD ï 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 & Weihhrich 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.

EXT 508 VISUAL COMMUNICATION 2+1 SEM - I

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 makesthe students to understand, prepare and present the scientific data effectively by using low cost visuals. The course also exposes the students to various Digitized video material in multimedia and also enable to design visuals for print, TV and know-how about scanning of visuals.

Theory

UNIT-I: Role of visuals & graphics in Communication. Characteristics of visuals & graphics. Functions of visuals and graphics. Theories of visual perception. Classification and selection of visuals.

UNIT-II: Designing message for visuals, Graphic formats and devices. Presentation of Scientific data. Principles and procuction of low cost visuals.

UNIT-III: Photographs- reprographic visuals. PC based visuals. Degitized video material in multimedia production. Designing visuals for print and TV and video.

UNIT-IV: Pre-testing and evaluation of visuals. Scanning of visuals.

Practical

Preparation of low cost projected and Non-Projected visuals. Designing and layout of charts, posters, flash cards etc. Power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

Suggested Readings

Bhatia A. 2005. *Visual Communication*. Rajat Publications.

Edgar Dale 1970. *Audio Visual methods in Teaching.*

James WB, Richard BL & Fried F Harcleroad. 1952. *A.V. Instructional Material & Methods*. Mc.Graw Hill.

Reddy YN. 1998. *Audio Visual Aids in Teaching, Training and Extension*. Haritha Publ. House.

EXT 509 PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER 1+1 SEM - II

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 ï 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 ï 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.

Suggested Readings

Adhikary. 2006. *Participatory Planning and Project Management in Extension Science*. Agrotech Publ. Academy.

Mukharjee N. 2002. *Participatory Learning and Action*. Concept Publ. Co.

Singh BK. 2008. *PRA/PLA and Participatory Training*. Adhyayan Publ. & Distr.

Somesh Kumar. 2002. *Methods for Community Participation*. Vistaar Publ.

EXT 510 GENDER SENSITIZATION FOR DEVELOPMENT 1+1 SEM - II

Objective

In this course the students will learn about an overview of the concept of gender and gender balance on development and develop skills of identifying gender roles, rights, responsibilities and relationships on development. Besides the students will also learn the attitudinal change to internalize gender equity concerns as fundamental human rights and also enhance the capability for identifying and analyzing gender issues in agriculture and allied sectors.

Theory

UNIT-I: Gender concepts, issues and challenges in development; Gender roles, gender balance, status, need and scope; Gender analysis tools and techniques.

UNIT-II: National policy for empowerment of women since independence; Developmental programmes for women; Gender mainstreaming in agriculture and allied sectors ï need and relevance; Gender budgeting ï A tool for empowering women.

UNIT-III: Women empowerment ï Dimensions; Women empowerment through SHG approach; Women entrepreneurship and its role in economic development; Public Private Partnership for the economic empowerment of women; Building rural institution for women empowerment; Women human rights ; Action plans for gender mainstreaming.

Practical

Visits to rural institutions of women for studying in the rural institutions engaged in Women empowerment; Visits to entrepreneurial unit of women for studying the ways and means of establishing entrepreneurship units for Women and their development and also SWOT analysis of the Unit; Visit to Center for women development - NIRD to study the different activities related to projects and research on gender; Visit to gender cell, Office of the Commissioner and Director of Agriculture, Hyderabad, to study the mainstreaming of gender concerns and gender budget of the department.

Suggested Readings

Grover I & Grover D. 2002. *Empowerment of Women*. Agrotech Publ. Academy.

Porter F, Smyth I & Sweetman C.1999. *Gender Works: Oxfarm Experience in Policy and Practice*. Oxfarm Publ.

Raj MK. 1998. *Gender Population and Development*. Oxford Univ. Press.

Sahoo RK & Tripathy SN. 2006. *SHG and Women Empowerment*. Anmol Publ.

Sinha K. 2000. *Empowerment of Women in South Asia*. Association of Management Development Institution in South Asia, Hyderabad.

Thakur Joshi S. 1999. *Women and Development*. Mittal Publ.

Vishwanathan M. 1994. *Women in Agriculture & RD*. Rupa Books.

EXT 511 PERSPECTIVES OF DISTANCE EDUCATION 1+1 SEM - II

Objective

The course is intended to orient the students with the concept of Distance Education, Characteristics of Distance Education, Evolution, Methods of Distance Education, Different Approaches in Planning Distance Education, Educational Technology in Distance Education, Management of Resources for distance education, Strategies for maximizing the reach and programme evaluation and quality assessment.

Theory

UNIT-I: Distance Education ï Introduction Meaning, Concept, Philosophy and its work ethics, characteristics of Distance Education ï Evolution and Historical view of Distance Education ï Theory Methodology, and Epistemology. Dimensions of Distance Education,

Scope and difficulties. Open Education ï Non-formal Education, Continuing Education, Education by correspondence.

UNIT-II: Forms and systems of Distance and Open Education, Modes of Teaching and Learning in Distance Education, Methods of Distance Education, Significance of Distance Education in Teacher Education.

UNIT-III: Planning Distance Education ï A Systems Approach Student Learning ï Course Planning, The target groups ï Barriers to learning in Distance Education ï Planning and Management of Networked Learning.

UNIT-IV: Educational Technology is Distance Education Application of information and Educational Technologies in Distance Education, Development of Course and Course material, Management of resources, processes, Forms of Instructional material in Distance Education and Media Development and Production in Distance Education - Video Classroom Strategy in Distance Education ï Strategies for maximizing the reach ï services to students, programme Evaluation - performance indicators and Quality Assessment.

Practical

Visit to the University which is implementing the Distance Education Programmes. Detailed Study of their programme in relation to Educational Technology, Methodology, Curriculum Development, Evaluation and Assessment. Exercise on development of curriculum for Distance Education exclusively for farming community.

Suggested Readings

Holmberg B. 1995. *Theory and Practice of Distance Education*. Routiedge Publ.

Lakshmi Reddy MV. 2001. *Towards Better Practices in Distance Education*. Kanishka Publ.

More MG. 2003. *Hand Book of Distance Education*.Lawrence Erlbaum Associates Publ.

Panda S. 2003. *Planning & Management in Distance Education*. Kogan Page Publ.

Pathak CK. 2003. *Distance Education: Prospects and Constraints*. Rajat Publ.

Sharma DC. 2005. *Management of Distance Education*. Anmol Publ.

Sharma M. 2006. *Distance Education: Concepts and Principles*. Kanishka Publ.

EXT 601 ADVANCES IN AGRICULTURAL EXTENSION 2+1 SEM - I

Objectives

By the end of the course student will be able to:-

- Critically analyze different Agricultural Extension approaches
- Understand Agricultural Knowledge Information System (AKISs) ITK
- Understand Advances in Extension - Cyber extension, ICT enabled extension services; Market Led Extension, Public Private Partnership, Mainstreaming gender in extension organizational Innovations.
- Visualize implications of WTO - AOA and develop extension strategies.
- Understand extension reforms and Farmer Field Schools Decentralized Decision Making, bottom up planning, ATMA, FSBE & CIGs etc., ATIC, IVLP & Kisan Call Centres

Theory

UNIT-I: Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

UNIT-II: Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact of agricultural extension, alternative methods of financing agricultural extension - Scope, limitations 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. Stakeholderôs 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.

Suggested Readings

Bagchi J. 2007. *Agriculture and WTO Opportunity for India*. Sanskruti.

Chambers R, Pacy A & Thrupp LA. 1989. *Farmers First*. Intermediate Technology Publ.

Crouch BR & Chamala S. 1981. *Extension Education and Rural Development*. Macmillan.

John KC, Sharma DK, Rajan CS & Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems*. MANAGE, Concept Publ. Co.

Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.

Narasaiah ML. 2005. *Agricultural Development and World Trade Organization*. Discovery Publ.

Talwar S. 2007. *WTO Intellectual Property Rights*. Serials Publ.

Van den Ban BW & Hawkins BS. 1998. *Agricultural Extension*. S.K. Jain Publ.

Venkaiah S. 2001. *New Dimensions of Extension Education*. Anmol Publ.

EXT 602 ADVANCED DESIGNS AND TECHNIQUES IN SOCIAL SCIENCE RESEARCH 2+1 SEM - I

Objective

By the End of the course student will be able to:-

- Develop & Standardize Attitude scale using different techniques of attitude scale construction.
- Develop skills of using Projected & Semi Projected & Semi Projected Techniques, Computer Package analysis and PRO Tools in Extension Research.

Theory

UNIT-I: Scaling technique - meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Reliability and Validity of Scales. Sociometrics, content analysis, case studies, Q-sort techniques, Semantic different technique.

UNIT-II: Projective and Semi projective techniques, Critical incident techniques, Computer packages for analysis - usage in Extension Research. Knowledge scale measurement. Participatory tools and techniques in behaviour Research - Data collection and Evaluation. Impact analysis, e-data collection and information analysis.

Practical

Practice in constructing a scale and use of scale in various situations. Reliability and validity of the scales developed, Application of Semi Projective and Projective techniques. Content analysis, case studies. Practicing participatory tools and techniques. Hands on experience on Computer Preparation and Data Collection instruments, review of previous studies.

Suggested Readings

Burns RB. 2000. *Introduction to Research Methods*. Sage Publ.

Chandrakandan K & Karthikeyan C. 2004. *Behavioral Research Methodology*. Classical Publ.

Daivadeenam P. 2002. *Research Methodology in Extension Education*. Agro-Tech Publ. Academy.

Kerlinger N Fred. 2002. *Foundations of Behavioural Research*. Surjeet Publ.

Kothari CR. 2000. *Research Methodology Methods & Techniques*. 2nd Ed. Wishwa Prakasham.

Ray GL & Mondal S. 1999. *Research Methods in Social Science and Extension Education*. Naya Prokash.

Roger L & Domino WSK. 1980. *Research Methods*. Prentice Hall.

Sadhu AM & Singh A. 2003 *Research Methodology in Social Science*. Himalaya Publ. House.
Sarantakos S. 1998. *Social Research.* 2nd Ed. Macmillan.
Sinha SC & Dhiman AK. 2002. *Research Methodology*. ESS Publ.
Verma RK & Verma G. 2002. *Research Methodology*. Commonwealth Publ.
Walizer MH & Panl L. 2002. *Research Methods & Analysis; Searching for Relationships.* Wiemil Harper & Row.
Wilkinson TS & Bhandarkar PL. 2002. *Methodology and Techniques of Social Research*. Himalaya Publ. House.

EXT 603 ADVANCES IN TRAINING TECHNOLOGY 2+1 SEM - II

Objectives

By the end of the Course student will be able to:-

- Plan and design a training programme
- Plan & Develop effective training sessions
- Manage difficult situations while organizing training programmes
- Use different advanced participatory training methods

Theory

UNIT-I: Paradigm shift in training - learning scenario, Training Approaches - Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, Harmonizing training needs, Course Objective, content and methods.

UNIT-II: Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).

UNIT-III: Recent Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools: TAT, Inventories, Cases, etc.

UNIT-IV: Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainerôs roles and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.

Practical

Techniques of participatory training need assessment. Formulation of Course Objective, design of training programmes. Simulation exercises. Participatory training methods - Role Play & Brainstorming, Group discussion and Counseling and Conducting experiential learning sessions. Training evaluation - Techniques of Knowledge, Skill & Attitude evaluation. Visit to training institutions and study of training technologies followed.

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.
Alan B & Calardy 2004. *Five Case Studies in Management Training.* Jaico Publ.
Kumar A. 2000. *Management Training Process.* Anmol Publ.
Leslie Rae. 1998. *Techniques of Training*. Jaico Publ.
Lynton RP & Pareek U. 1999. *Training for Development*. 2nd Ed. Vistar Publ.
Reid MA. 1997. *Training Interventions, Managing Employee Development*. Jaico Publ.
Samanta RK. 1993. *Training Methods for Management and Development*. M.D. Publ.
Sethy ED. 2003. *A Practical Hand Book on Training*. Anmol Publ.

EXT 604 ORGANIZATIONAL DEVELOPMENT 2+1 SEM - II

Objective

By the end of the course student will be able to Understand & Study the Organization in terms of types, Characteristics, Needs, Motives, Organization behaviour, Organization Communication, Organization development and Individual behaviour in organization. To anlayse the factors effecting organizational effectiveness and distinguish between functional and non functional organization.

Theory

UNIT-I: Introduction to organizations: Concept and Characteristics of organizations, Organizational Behvaiour - Context and concept - levels of organizations - formal and

informal organizations, Theories of organizations: Nature of organizational theory - classical theories - features of Bureaucracy - administrative theory and Scientific management - Neo-classical theories - the human relations movement - modern theory.

UNIT-II: Systems approach to study organization needs and motives - Attitude, values and ethical behaviour - alienation and work - work motivation - communication and interpersonal behaviour - organization communication - leadership behaviour - decision making, problem solving techniques - organizational climate - change proneness and resistance to change, Organizational change, Organizational structure - Process in organizing - Dimension of Motivation Climate.

UNIT-III: Departmentation - Span of Management - Delegation of authority - Centralization and decentralization - line and staff organization - functional organization - divisonalisation - Project organization - Matrix organization - free form organization - top management structure.

UNIT-IV: Individual behaviour in organization. Fundamentals of Human relations and Organizational behaviour, Groups and teams - Organisational culture and performance. Dynamics of Organization behaviour - leadership conflict situations and inter group behavior- Organisational Development - Factors effecting organization effectiveness. Creativity, leadership, motivation and organization development.

Practical

Analysis of organization in terms of process - attitudes and values, motivation, leadership. Simulation exercises on problem-solving - Study of organizational climate in different organizations. Study of organizational structure of development departments, Study of departmentalization, span of control delegation of authority, decisions making patterns, Study of individual and group behaviour at work in an organization. Conflicts and their management in an organization. Comparative study of functional and non-functional organsiations and drawing factors for organizational effectiveness.

Suggested Readings

Ancona, Kochaw, Scully, Van Maanen, Westney 1999. *Organizational Behaviour and Processes*. South Western College Publ.

Banerjee M. 1984. *Organizational Behaviour*. Allied Publ.

Deka GC. 1999. *Organizational Behaviour - A Conceptual Applicational Approach*. Kanishka Publ.

Dwivedi RS. 2006. *Human Relations and Organization Behaviour- A Global Perspective.* 5th Ed. Macmillan.

Kumar A. 2000. *Organizational Behaviour Theory and Practice*. Anmol Publ.

Luthans F. 1998. *Organizational Behavior*. Tata McGraw Hill.

Luthans F. 2001. *Organizational Behaviour*. McGraw Hill.

Newstrom JW & Davis K. 1997. *Human Behaviour at Work*. Tata McGraw Hill.

Robbins SP. 2007. *Organizational Behaviour*. Prentice Hall.

Shaun T & Jackson T. 2003. *The Essence of Organizational Behaviour*. Practice Hall of India.

Stephen RR. 1999. *Organizational Behaviour*. 5th Ed. Practice Hall of India.

EXT 605 ADVANCED INSTRUCTIONAL TECHNOLOGY 2+1 SEM- I

Objectives

By the end of the course student will be able to:-

- Understand Agricultural Education Scenario in the country and Curriculum development process
- Plan & Prepare and present course outline, Lesson Plan & Skill plan
- Develop appropriate Teaching & Learning Styles
- Use innovative instructional aids & methods

Theory

UNIT-I: Concepts in Instructional Technology, Scope of Instructional Technology. History of agricultural education in India. Guidelines for curriculum development in Agricultural Universities. Curriculum design development.

UNIT-II: Course outline, Lesson plans for theory and practicals. Teaching and learning styles. Theories of learning. Cognitive levels. Instructional Course Objective. Motivation of students.

UNIT-III: Instructional Methods. Experiential learning cycle. Innovative Instructional Aids. Computer Assisted Instruction. Programmed instruction technique. Team Teaching.

E-Learning, Art of Effective Communication. Distance education. Student evaluation - Question Bank. Appraisal of Teacher Performance. Review of research in Instructional Technology.

Practical

Formulation of instructional Course Objective. Development and presentation of course outlines. Preparation & presentation of lesson plans for theory & practical with CAI design. Preparation of innovative low cost instructional aids. Development of model question bank. Preparation of schedule for teacher evaluation. Visit to Distance Education centre. Study of research reviews and Presentation of reports.

Suggested Readings

Agarwal JC. 2007. *Essentials of Educational Technology Innovations in Teaching – Learning*. 2nd Ed. Vikas Publ. House.

Agarwal R. 2000. *Educational Technology and Conceptual understanding*. Anmol Publ.

Dayal BK. 2005. *Educational Planning and Development*. Dominant Publ.

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

Jacobsen D, Eggen P & Kauchak D. 1985. Methods for Teaching - A Skills Appraoch. 2nd Ed. Charles E. Merrill Publ.

Joyee B & Well M. 1980. *Models of Teaching*. 2nd Ed. Prentice Hall.

Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.

Rush N. 1987. *Technology Based Learning - Selected Readings*. London Publ. Co.

Tara Chand 1999. *Educational Technology*. Anmol Publ.

EXT 606 COMPARATIVE EXTENSION 3+0 SEM - II

Objective

By the end of the course student will be able to understand the different extension programmes/ approaches and systems of the developed and underdeveloped countries.

Theory

UNIT-I: Genesis of extension programmes: development of extension work in USA and implications of the legislative measures; extension work in UK, China, Neatherlands and Afro-Asian countries.

UNIT-II: Efforts made for social welfare in the past and progress of the NES and Community Development Programme in India.

UNIT-III: Distinguishing characteristics of the Indian extension system with that of the USA, Neatherlands, Japan, Pakishtan, Taiwan, Australia and Denmark; Critical appreciation of the Community Development Programme of India

Suggested Readings

Axinn George H & Thorat SS. 1972. *Modernizing Agricultural World Wide.* Oxford & IBH.

Cernea MM, Russel JFA & Coulter JK. (Eds.). 1983. *Agricultural Extension by Training and Visit- The Asian Experience*. The World Bank Washington D.C.

Dantwala ML & Barmeda JN. 1990. *Rural Development Approaches and Issues, Indian Ag. Dev. Since Independence*. Oxford & IBH.

Dhama OP & Bhatnagar OP. 1991. *Communication for Development.* Oxford & IBH.

Mondal S & Ray GL. 2007 *A Text Book of Rural Development*. Kalyani.

Rivera WH. 1987. *Agricultural Extension World Wide Issues, Practices and Emerging Pririties*. Croom Helm.

EXT 607 ADVERTISING AND MARKETING COMMUNICATION 1+1 SEM - I

Objective

To help the students to know the concept,evaluation, history, classification, various media for advertising, socio-economic effects of advertising, trends in advertising and marketing, govt. policy on advertising and marketing and to develop competency in creating advertisements for mass communication.

Theory

UNIT-I: Evaluation and history of advertising, relevance of advertising in marketing, an overview of the advertising scene in India.

UNIT-II: Classification of advertising; various media for advertising, advertising writing process; law and ethics in advertising, socio-economic effects of advertising.

UNIT-III: Advertising agency, operations/management , an understanding of key issues, strategies in advertising govt policy on advertising and management, apex bodies in advertising.

UNIT-IV: Advertising as a tool of marketing and Advertising campaigns and their role in marketing; Marketing communication - concept and functions, consumer behaviour and its various factors; recent trends in advertising and marketing.

Practical

Visit to advertising agencies, advertising layout techniques for newspaper, radio, posters, TV, hoardings, wall paintings, case studies on institutional advertisement, advertisement campaign.

References

Chunawala SA. 2003. *Advertising an Introductory Text.* Himalaya Publ. House.

Derek Townsend 1993. *Advertising and Public Relations.* Alvin Rednam.

Ganesh S. 2005. *Introduction to Advertising.* Radha Publ.

Thomas CO Grim, Allen CT & Richard J Semenik 2003. *Advertising and Integrated Brand Promotion.* Vikas Publ.

Verma S. 2004. *Entrepreneurship and Effective Marketing,* Aavishkar Publ.

EXT 608 MEDIA MANAGEMENT 2+1 SEM - I

Objectives

- To familiarize the students with the working of print, electronic, New Media and Traditional folk media.
- To develop working skills needed for Print, Radio and T.V. Journalism to reach farming community.
- To develop in students an understanding on Mass Communication Process and Media Management its impact on the society.
- To develop writing skills for different media.

Theory

UNIT-I: Media Management ï Introduction, Definition, Principles and Significance of Management. Media Ownership patterns in India ï Proprietorship, Partnership, private Ltd, Public companies, Trusts, Co-operatives, Religious Institutions (Societies) & Franchisees (Chains). Marketing Function ï Product, Price, and Placement & Promotions.

UNIT-II: Mass Communication ï Meaning, Concept, Definition and Theories of Mass Communication. The Mass Media ï History, functions, uses and Theories of Media. Journalism ï Meaning, definition, Scope, functions and different types of Journalism. Journalism as communication tool. Farm Journalism ï meaning and Developments in Farm Journalism in India. Different problems with Farm Journalism. Print Media ï History, the role of the press, news, Types of News, electronics of News and Sources of News, the making of newspaper & magazines, press codes and ethics, Media Laws. News story ï Principles of writing, structure a news story, procedure in writing the news story and the elements of style. Success stories & feature articles ï writing for success & feature articles, Types of Feature articles. Information materials ï Types of information materials and user. Techniques in book Publishing. Editing ï Principles, Tools & Techniques and art of Proof Reading ï Techniques, Measuring Readability of writing.

UNIT-III: Electronic Media-Role and Importance of Radio -History, Radio Role in TOT, writing and presentation techniques, Different Programmes of Farm Broadcast, developing content for farm broadcast, Role of FM Radio in Agriculture, Ethics of Broad casting, Broadcasting Policy and code. Community Radio ï Concept, meaning, role in TOT, Cases of Community radio. Television ï History - Role in TOT , Fundamentals of Television Production, Techniques of Script writing for TV, Visual Thinking, language & Style, Farm Telecast programmes, cable and satellite TV and their impact, Ethics of Telecasting, policy and code.

Video Production Technology – Potential and its utilization, Typology of farm Video production, Types of Video Production and equipment used in the production, Procedure or Technique of video production. Cassette Technology ï Role in TOT, Techniques of production of cassettes for the farming community. Traditional Media ï Role of Folk Media in TOT and integration with electronic media.

UNIT-IV: Advances in communication Technology ï Management of Agricultural Information System (MAIS). Use of computers in Agriculture ï Application of IT in Agriculture. Use of Modern Communication Medium- Electronic Video, Teletext, tele

conference, Computer assisted instruction, Video conferencing, - Features, Advantages, Limitations and risk factory involved in New Media. Designing and developing of communication and media strategy for developmental programmes. Online journalism scope & importance.

Practical

Exercise on Writing for Print Media ï Writing News / Success Stories / Feature articles for different topics related to Agriculture & allied fields. Exercise of editing & proof reading the Farm News for News papers ï different types of intro and leads. Exercise of Writing for Radio, TV, Preparation of story board for farm Video Production ï Script writing for Radio and T.V. Visit to media management organizations for studying the principles, procedures and processes in managing the media. Participation and Interaction through video conference. Developing communication & Media Strategy for selected developmental programme / activity.

Suggested Readings

Bhaskaran C, Prakash R & Kishore Kumar N. 2008. *Farm Journalism in Media Management*. Agro-Tech Publ. Academy.

Chattergee PC. 1991. *Broadcasting in India*. Sage Publ.

Chiranjeev A. 1999. *Electronic Media Management*. Authors Press.

DõSouza YK.1998. *Principles and Ethics of Journalism and Mass Communication*. Commonwealth Publ.

Defleur ML & Dennis EE. 2001. *Understanding Mass Communications*. Goyalsaab Publ.

Jain SC. 2006. *International Marketing Management*. CBS Publ.

Keval J Kumar. 2004. *Mass Communication in India.* Jaico Publ.

Malhan PN. 2004. *Communication Media: Yesterday, Today and Tommorow*. Directorate of Publication Division, New Delhi.

Mehta DS. 1992. *Mass Communication and Journalism in India*. Allied Publ.

Panigrahy D. 1993. *Media Management in India.* P. K. Biswasroy (Ed.). Kanishka Publ.

Shrivastava KM. 1995. *News Writing for Radio and TV*. Sterling Publ.

Sinha KK. 2001. *Business Communications*. Galgotia Publ.

EXT 609 TRANSFER OF TECHNOLOGY IN AGRICULTURE 2+1 SEM - II

Objectives

By the end of the Course student will be able to:-

- Develop thorough understanding on different systems of Technology Transfer
- Develop appropriate communication & Media Strategy suitable to the System of Technology Transfer
- Analyse the constraints in Systems of Technology Transfer Technology and Suggest suitable Strategies.

Theory

UNIT-I: Technology - Meaning and Concepts - Appropriate technology, transfer of technology - meaning and concepts. Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) - Knowledge Consuming System (KCS) - Input Supplying Agencies System (ISAS).

UNIT-II: Appropriateness of communication media in the system of technology transfer. New communication strategy for transfer and adoption of Agricultural technology. Extension training in transfer of technology.

UNIT-III: Analysis. Constraints in Transfer of Technology, agencies or departments involved in TOT. Extension professional in TOT. Attributes of Technology and its Relation in TOT process. TOT to resource poor farmers. Role of Key communicators or local leaders in TOT. Private and Public partnership in TOT.

Practical

Analysis of Transferred technology. Analysis of knowledge generation and consuming systems. Formulation of communication strategies, Study of attributes of selected fast spreading technologies and slow technologies, study of constraints in TOT, visit to TOT centres of ICAR and SAU, Identification of key communicators, Case studies of Public-Private Partnerships, Visits to the print and electronic media centres to study their role in TOT.

Suggested Readings

Chaturvedi TN. 1982. *Transfer of Technology among Developing Countries; Need for Strengthening Cooperation*. Gitanjali Publ. House.

Dunn DD. 1978. *Appropriate Technology With a Human Face*. Macmillan Press.
Kapoor SK, Roy PB & Roy AK. 1980. *Role of Information Centres in Technology Transfer*. IASLIC, Kolakata.
Lekhi RK. 1984. *Technological Revolution in Agriculture*. Classical Publ. Co.
Singh SN. 1991. *Transfer of Technology to Small Farmers; An Analysis of Constraints and Experience*. Concept Publ. Co.
Wallender HW. 1980. *Technology Transfer of Management in the Developing Countries*. Ballinger Publ. Co., Cambridge.

EXTENSION EDUCATION & COMMUNICATION MANAGEMENT

List of Journals

- Agricultural Extension Review
- British Journal of Educational Technology
- Economic and Political Weekly
- European Journal of Agricultural Education and Extension
- Indian Economic Panorama
- Indian Journal of Adult Education
- Indian Journal of Extension Education
- Indian Journal of Human Development
- Indian Journal of Open Learning
- Indian Journal of Social Development
- Indian Journal of Social Work
- Indian Journal of Training and Development
- Indian Social Science Review
- International Journal of Business and Globalization
- International Journal of Sustainable Development
- Journal of Asia Entrepreneurship and Sustainability
- Journal of Development Studies
- Journal of Educational Planning and Administration
- Journal of Educational Psychology
- Journal of Environmental Extension
- Journal of Environmental Studies and Policy
- Journal of Extension
- Journal of Extension Education
- Journal of Extension System
- Journal of International Agriculture and Extension Education
- Journal of Rural Development
- Journal of Sustainable Agriculture
- The Journal of Entrepreneurship

e- Resources

- www.pearsoned.com (Pearson Education Publication)
- www.mcgraw-hill.com (McGraw-Hill Publishing Company)
- www.oup.com (Oxford University Press)
- www.emeraldinsight.com (Emerald Group Publishing)
- www.sagepub.com (Sage publications)
- www.macmillanindia.com (Macmillan Publishing)
- www.krishiworld.com (Agriculture Portal)
- www.aiaee.org (The Association for International Agricultural and Extension Education)
- www.geogate.org (Agriculture Portal)
- www.icar.org.in (Indian Council of Agricultural Research)
- www.manage.gov.in (National Institute of Agricultural Extension Management)

Suggested Broad Topics for Master's and Doctoral Research

- Agricultural communication
- Agricultural Journalism
- Agriculture Education
- Agro Forestry Extension
- Banking & Credit
- Commercialization and Diversification in Agriculture
    - Vegetables
    - Horticulture
    - Agri. tourism
    - Floriculture
    - Mushroom cultivation

    - Bee Keeping
    - Organic Farming
- Cropping System/Farming System
- Diffusion and Adoption
- Dry Farming Technology
- Entrepreneurship Development
- Extension Administration and Management
- Extension Methods and techniques
- Extension Trainings
- Extension Management and Sustainable Agricultural Development
- Indigenous Practices
- Rural Organization and Institutions
- Scientific Productivity and Human Resource Development
- Youth/Women Development
- Social Marketing

FORESTRY

Course Structure

COURSE NO	COURSE TITLE	CREDITS	SEM
FOR 501*	SILVICULTURE	2+0	II
FOR 502*	FOREST BIOMETRY	1+1	II
FOR 503*	FOREST MANAGEMENT	2+0	I
FOR 504*	FOREST PRODUCTS ï CHEMISTRY AND INDUSTRIES	1+1	II
FOR 505*	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1	I
FOR 506*	AGROFORESTRY SYSTEMS	1+1	II
FOR 507*	FOREST PROTECTION	1+1	II
FOR 508*	TREE IMPROVEMENT	1+1	II
FOR 509	PLANTATION FORESTRY	2+1	II
FOR 510	ECONOMICS OF AGROFORESTRY SYSTEMS	2+1	II
FOR 511	BREEDING METHODS IN FOREST TREES	2+1	I
FOR 591	MASTERõS SEMINAR	1	I, II
FOR 599	MASTERõS RESEARCH	20	I, II
FOR 601**	QUANTITATIVE SILVICULTURE	2+1	II
FOR 602**	ADVANCES IN TREE IMPROVEMENT	2+1	II
FOR 603**	ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS	3+0	I
FOR 604**	AGROFORESTRY SYSTEMS AND MANAGEMENT	1+1	II
FOR 605**	FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION	1+1	I
FOR 606	ADVANCES IN SILVICULTURE	1+1	II
FOR 607	ADVANCES IN FOREST REPRODUCTIVE BIOLOGY	1+1	I
FOR 608	ADVANCES IN AGROFORESTRY RESEARCH AND MANAGEMENT	2+0	I
FOR 691	DOCTORAL SEMINAR-I	1	I, II
FOR 692	DOCTORAL SEMINAR-II	1	I, II
FOR 699	DOCTORAL RESEARCH	45	I, II
Compulsory Non-Credit Deficiency Courses (For non - Forestry Graduates)			
FOR 451	PRINCIPLE AND PRACTICES OF SILVICULTURE	2+0	I
FOR 452	FOREST MENSURATION	1+1	I
FOR 453	PRINCIPLES OF TREE IMPROVEMENT	1+1	I
FOR 454	WOOD PRODUCTS AND UTILIZATION	1+1	I
FOR 455	FOREST MANAGEMENT, POLICY AND LEGISLATION	1+1	I
Supporting courses for M. Sc.			
STAT 511*	STATISTICAL METHODS FOR APPLIED SCIENCES	3+1	
Supporting courses for Ph. D.			
STAT 512**	EXPERIMENTAL DESIGNS	2+1	
SOILS 510	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	2+1	
SERVICE COURSE			
AGRON 510	AGROSTOLOGY AND AGROFORESTRY	2+1	I

* Compulsory for M.Sc. Programme; **Compulsory for Doctoral Programme.

FORESTRY

Course Contents

FOR 501 SILVICULTURE 2+0 SEM - II

Objective

To provide knowledge about Forest ecosystem concept, stand dynamics, forest succession, productivity and vegetation forms and natural regeneration of tree species.

Theory

UNIT-I: Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of worldôs forest vegetation.

UNIT-II: Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT-III: Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-Applied Forest Ecology*. John Wiley & Sons.

FOR 502 FOREST BIOMETRY 1+1 SEM - II

Objective

To develop understanding of students about tree measurements, forest inventory and yield concepts

Theory

UNIT-I: Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands,. Preparation of volume & its application, yield and stand tables.

UNIT-II: Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT-III: Growth and yield prediction models ï their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.

Ram Parkash 1983. *Forest Surveying*. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 503 FOREST MANAGEMENT 2+0 SEM - I

Objective

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density & forest valuation.

Theory

UNIT-I: Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT-II: Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies.

UNIT-III: Forest valuation and appraisal in regulated forests.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-Applied Forest Ecology*. John Wiley & Sons.

FOR 504 FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES 1+1 SEM - II

Objective

The course will equip the students regarding wood based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this wood extracts resins and gums, katha, tannis and various type of non timber products. Practical will make them aware regarding extracting method of different products of wood.

Theory

UNIT-I: Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products.

UNIT-II: Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes.

UNIT-III: Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood ï water and organic solvent soluble.

UNIT-IV: Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT-V: Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

Practical

Estimation of cell wall contents ï Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood, Visit to nearby forest based industries.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR.
Anonymous. 2007. *Year Book of Forest Products*. FAO.
Dwivedi AP. 1993. *Forestry in India*. Surya Publ.
Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

FOR 505 FOREST ECOLOGY AND BIODIVERSITY CONSERVATION 2+1 SEM - I

Objective

To develop understanding of students about ecological aspects of forest, conservation of forest resources & biodiversity, consequences of depleting biodiversity and sustainable use of biodiversity.

Theory

UNIT-I: Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology.

UNIT-II: Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservations laws and acts. Forest genetics resources of India: timber and non timber species. Survey exploration and sampling strategies.

UNIT-III: Documentation and evaluation of forest genetic resources (FGR), *in situ* and *ex situ* conservation of gene resources. Biological diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

Practical

Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem, Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen, Methods of vegetation analysis, Measurement of biomass and productivity, Quantification of litter production and decomposition, Visit to national parks, wldlife sanctuaries, botanical gardens and arboreta.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India.
Dhyani SN. 1994. *Wildlife Management*. Rawat Publ.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell.
Khan TI & Al-Azmi DN. 1999. *Global Biodiversity Conservation Measures*. Pointer Publ.
Kimmins JP. 1976. *Forest Ecology*. MacMillan.
Nautiyal S & KoulAK. 1999. *Forest Biodiversity and its Conservation Practices in India*. Oriental Enterprise.
Ramakrishnan PS. 1992. *Shifting Agriculture and Sustainable Development*. Man and Biosphere Series. The Parthenon Publ. Group.

FOR 506 AGROFORESTRY SYSTEMS 1+1 SEM - II

Objective

To impart knowledge on the concept of agroforestry land use including diagnosis and design methodologies.

Theory

UNIT-I: Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation.

UNIT-II: Overview of global agro-forestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Production potential of different silvi-pasture system.

UNIT-III: Concepts of community forestry and social forestry, linear strip plantations.

UNIT-IV: Diagnosis and Design ï Trends in Agroforestry systems research and development.

Practical

Survey and analysis of land use systems in the adjoining areas. Design and plan of suitable models for improvement.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI.

FOR 507 FOREST PROTECTION 1+1 SEM - II

Objective

To provide knowledge to students about forest protection through diseases and pest management.

Theory

UNIT-I: Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management.

UNIT-II: Biodegradation of wood ï microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots ï factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health.

UNIT-III: Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

UNIT-IV: Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistant trees.

Practical

Collection, identification and preservation of important insect pests and disease specimens of forest plants. Detection of insect infestation and seed borne mycoflora. Assessment of losses due to diseases, insect pests etc. Habitat management of vertebrate pests. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio-control agents in the management of insect pests, weeds,

diseases in nurseries and plantations, Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycrorrhizal root infection.

Suggested Readings

Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.
Jha LK & Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House.
Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall.
Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.

FOR 508 TREE IMPROVEMENT 1+1 SEM - II

Objective

To acquaint the students about general principles of tree breeding with examples of important trees.

Theory

UNIT-I: General concept of forest tree breeding, tree improvement and forest genetics.
UNIT-II: Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms.
UNIT-III: Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations ï Ecotypes, clines, races and land races.
UNIT-IV: Seed, seed formation, dispersal, storage, stratification and seed dormancy.
UNIT-V: Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses.
UNIT-VI: Progeny and clone testing. Seed orchards ï type, functions and importance. Estimating genetic parameters and genetic gain.
UNIT-VII: Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples ï teak, *Prosopis*, shisham, eucalypts, acacias, Ailanthus and poplars.
UNIT-VIII: Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-weinberg law, null hypothesis, Wohlundôs Principle.
UNIT-IX: Biotechnology in tree improvement. Mutation breeding.
UNIT X: Economics of tree breeding.

Practical

Floral biology, modes of reproduction and modes of pollination in forest trees. Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones. Identification of ecotypes, races, and land-races in natural forest. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids. Induction of polyploidy through colchicine treatment.

Suggested Readings

Mandal AK & Gibson GL. (Eds). 1997. *Forest Genetics and TreeBreeding*. CBS.
Surendran C, Sehgal RN & Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR.
White JW. 1976. *Introduction to Forest Genetics*. Academic Press.
Zobel BJ & Talber J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

FOR 509 PLANTATION FORESTRY 2+1 SEM - II

Objective

To acquaint with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations.

Theory

UNIT-I: Role of plantation forestry in meeting the wood demand ï Plantation forestry in India and abroad, Purpose of plantation, Factors determining scale and rate of plantation, Land suitability and choice of plantation species
UNIT-II: Production technology for quality planting stock, preliminary site preparation for establishing plantation, Planting programme, time of planting, planting pattern, spacing, plating method.
UNIT-III: Nutritional dynamics and irrigation of plantation, Mechanization in plantation, Protection and after care of plantation, Pruning and thinning of plantation for quality wood

production, Rotation in plantation, Failure of plantations, Impact of interaction and integration of plantation forestry, Protective Afforestation, afforestation of inhospitable sites, Ecological factors and long term productivity, Sustainable yield from plantation.

UNIT-IV: Case studies in plantations of Eucalyptus, Sissoo, Poplars, Acacias, *Prosopis cineraria*, *Ailanthus*, *A. indica* , Teak, *Melia sp*., Bamboo, etc.

UNIT-V: Wasteland plantation

UNIT-VI: Industrial Plantation

Practical

Analysis of plantation problems in Asia and India ï Preparation of plantation calendar ï Preliminary arrangement for a plantation programme ï Planting geometry and calculation of planting stock ï Study of different cultural operations and site preparation for plantation ï Studies on wood based industries ï Problems and prospects ï Management of Eucalyptus, Sissoo, Teak, *Melia sp*, Poplar, Acacias, *Ailanthus* and Bamboo plantations ï Production technology for energy plantations ï INM in plantations ï Irrigation and plantations ï Economics of plywood, pulpwood, timber and energy plantations.

Suggested Readings.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

FOR 510 ECONOMICS OF AGROFORESTRY SYSTEMS 2+1 SEM - II

(To be taught jointly by Agricultural Economics and Forestry)

Objective

To acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems.

Theory

UNIT-I: Basic principles of economics applied to agro-forestry. Optimization techniques-Planting, budgeting and functional analysis. Role of time, risk and uncertainty in decision making.

UNIT-II: Financial and socio-economic analysis of agro-forestry projects.

UNIT-III: Principles of financial management and harvesting, post harvest handling marketing of agro-forestry products including benefit sharing.

Practical

Exercises on agro-forestry production relationships. Preparation of enterprise, partial and complete budgets. Application of various methods in formulation and appraisal of agro-forestry projects. Case studies on harvesting, post harvest management and marketing of agro-forestry products.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

FOR 511 BREEDING METHODS IN FOREST TREES 2+1 SEM - I

Objective

To acquaint the students about the concepts of sub- selection, population structure for breeding and production, genetic testing and making designs.

Theory

UNIT-I: Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes.

UNIT-II: Long-term and short-term breeding populations. Selective breeding methods-mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations regression systems, mother tree selection, subjective evaluation. Selection for different traits.

UNIT-III: Genetic testing programmes ï mating designs, complete designs ï nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs ï open pollinated mating and polycross mating.

UNIT-IV: Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection.

UNIT-V: Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance.

UNIT-VI: Tree improvement case histories. Calculating gene and genotype frequencies. Flow chart for different breeding methods.

Practical

Half-sib, full-sib family in trees. Grading system of plus trees in natural stands. Mating designs, complete designs ï nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs ï open pollinated mating and polycross mating. Selection for biotic and abiotic stresses.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and TreeBreeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FOR 601 QUANTITATIVE SILVICULTURE 2+1 SEM - II

Objective

To assess growth functions, dynamics of even aged and uneven aged forest. Thinning and growth, self thinning rule or 3/2 power law of self thinning.

Theory

UNIT-I: Growth functions-empirical, exponential, allometry and Backmanôs growth function. Growth pattern and growth increment curve. Growth cycle and phases.

UNIT-II: Correlation between size and plant population. Probability of individual tree mortality. Models of mortality and yield for unthinned forest stands.

UNIT-III: Dynamics of even aged and uneven aged forests. Competition for space, light and nutrients in forest stands and their effect on population. Effect of thinning and growth. Plant geometry and self thinning. Stand structure and allometry of trees during self thinning of pure stand. Interpretation of self thinning rule. Detailed concept 3/2 power law of self thinning and its revaluation and modifications.

Practical

Growth characteristics and effect of temperature, nutrients and water stress on growth behaviour of nursery plants. Preparation of growth and increment curves.

Suggested Readings

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

FOR 602 ADVANCES IN TREE IMPROVEMENT 2+1 SEM - II

Objective

To develop understanding of students in application of mendelian, principles to forest trees and integration of physiological and molecular techniques for tree improvement programmes.

Theory

UNIT-I: Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees.

UNIT-II: Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees.

UNIT-III: Molecular genetics as applied to forest trees, recent trends in tree improvement, somatic hybrids, transformation, gene sequencing. Inheritance of monoterpene composition in conifers.

UNIT-IV: Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes.

UNIT-V: Geographic variation in trees, evolution and gene flow. Exploration and conservation of gene resources of trees. Dioecism and moneocism in trees.

Practical

Cytology of pine root tips, kryotypic analysis, mutagenic treatments with colchicine and MH, tissue culture of organs, and transformation experiments, resin tapping and observation of trees for menoecium and dioecium.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publ.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and TreeBreeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FOR 603 ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS 3+0 SEM - I

Objective

To acquaint the students regarding updated and advance technology of timber mechanics, wood derivatives, import and export potential of non timber forest produce and latest computer application in forest produces.

Theory

UNIT-I: Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing.

UNIT-II: Principles of industrial wood processes, Products derived from wood by chemical processes and value added wood products, Properties of construction, Wood polymers and surface chemistry, Fundamentals of adhesion and fracture in adhesively bonded wood, Adhesive systems used for wood with emphasis in wood based composites.

UNIT-III: Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.

UNIT-IV: Computer application system in forest products, Use of information technologies to integrate material, quality and market fluctuations.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR.

Anonymous. 2007. *Year Book of Forest Products*. FAO.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Gamble JS. 2002. *A Manual of Indian Timbers*. International Book Distr.

Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
Negi SS. 2007. *Wood Sciences and Technology*. International Book Distr.

FOR 604 AGROFORESTRY SYSTEMS AND MANAGEMENT 1+1 SEM - II

Objective

To impart knowledge on recent development on agroforestry models and its economics.

Theory

UNIT-I: Rationale for research proposals: live fences, boundary plantings, hedgerow intercropping, mixed intercropping, fodder banks, woodlots; Possible experimental designs

UNIT-II: The use of economics in diagnosis and design of Agroforestry systems; Costs and benefits in Agroforestry; Valuation of inputs and outputs; Environmental outputs

UNIT-III: Discounting rates for private and public economic analysis; Discounted measures of economic worth; Non-numerical economic analysis; Methodology for the exploration and assessment of multipurpose trees

UNIT-IV: General considerations; Collection of MPTs; Assessment and choice of experimental sites; Assessment of methodologies; Changes in plant species; Tree/crop interface approach; Systematic designs; Bivariate analysis for intercropping experiments; Modelling in Agroforestry; Elements.

Practical

Developing formats for diagnosis and design investigations; Discussion on published cases of discounting in Agroforestry; Valuation of input and output; Case study on B C ratios for community forestry; Scoring for multiple use of different species; Listing a hundred species of tropical origin; Market trends in tree based products; Study of impact of agroforestry/social forestry on wildlife; Birds and small animals; General of ergonomic data from Agroforestry practitioners in farmlands; Farmers responses to Agroforestry/community forestry; Studies on light and shade effects of trees on understorey plants. A review; The role of voluntary agencies/industries in promoting afforestation programmes; The impact of training to farmers, agricultural officers and others in promoting Agroforestry; Experience of Birsa Agricultural University. Constraints in adoption of Agroforestry; Farmers view point; Visit to agave & biofuel plantations and report on its management practices; Industry; Farmer nexus; Wasteland development; Fuel wood plantations, Biomass productivity assessment; Develop models for rehabilitation of saline and alkaline areas.

Suggested Readings

Chandawak BS & Gautam SK. 1993. *A Textbook of Agroforestry*. Oxford & IBH.
Dwivedi AP. 1992. *Agroforestry – Principles and Practices*. Oxford & IBH.
Huxley P. 1999. *Tropical Agroforestry*. Blackwell.
Jeffers JNR. 1978. *An Introduction to System Analysis with Ecological Application*. Edward Arnold.
Jha LK. 1995. *Advances in Agroforestry*. APH Publ.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Singh PO, Pathak PS & Roy MM. 1994. *Agroforestry Systems for Sustainable Land Use*. Oxford & IBH.
Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

FOR 605 FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION 1+1 SEM - I

Objective

To develop understanding of students about environmental sustainability and forestry interventions for environment amelioration

Theory

UNIT-I: Environmental amelioration ï concept and challenges. Integration of environmental conservation strategies and economic development.

UNIT-II: Forestry interventions viz. Plantation forestry, industrial forestry, urban forestry, fuelwood/energy forestry including biofuels, short rotation forestry, Agroforestry, biodiversity parks, Sanctuaries and national parks and catchment plantations.

UNIT-III: Impact of soil erosion, soil moisture regimes, fertility improvements, poverty alleviation, micro-environment native biodiversity and overall environmental sustainability.

UNIT-IV: Environmental concerns, monitoring methods, health & safety, environmental training, environmental organization.

Practical

Study structure an functions of forestry interventions. Analysis of the micro-environmental attributes viz. temperature, humidity, solar radiations, soil erosion, *in-situ* measurement of sediment load in native water bodies, native fauna and flora, measurement of particulate air pollutants and other gases.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997.

Natural Resource Economics – Theory and Application in India. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FOR 606 ADVANCES IN SILVICULTURE 1+1 SEM - II

Objective

To develop understanding of students about advance in Silviculture and silvicultural practice. Effect of silvicultural practices on forest stand management and stand development. Advances in coppice silviculture.

Theory

UNIT-I: Philosophy of silviculture ï Advance reproduction methods and their role in silviculture ï Judging successful establishment; Analysis of active and passive site preparation ï Silviculture with an ecosystem approach

UNIT-II: Advance silvicultural practices in rain forest; Tropical forest; Subtropical forest, Temperate forest; Mechanization and role in Silviculture

UNIT-III: Analysis of different techniques of silviculture in forest stand management, Technique for early stand development; Analysis of thinning methods and its impact on wood yield and quality; Stand protection and health management

UNIT-IV: Advance silviculture techniques for plantation forestry; Case studies of advance silviculture in India and abroad; Advances in coppice Silviculture.

UNIT-V: Adjusting silviculture to meet industrial demands ï Silviculture in perspective ï Problem solving procedure for silviculture ï Silviculture in retrospect.

Practical

Study of components of silvicultural system for sustained yield; Management strategies for even aged and uneven aged stands; Regeneration methods for specific sites; Choice of site preparation methods, Plantation map, Quality planting stock, Planning for tree planting, Release cutting operation, Selection of thinning methods, Intensity of thinning, Analysis of site quality and biomass production for timber, pulp wood and fuel wood species, Problems in silviculture in tropical, subtropical plantation and their solutions.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press.

Ford ED. 1984. *Nutrition of Plantation Forests*. Academic Press.

Kadambi K. 1993. *Silviculture and Management of Teak*. Vedams Books International.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Sairll PS, Evans J, Auclair D &Flack J. 1997. *Plantation Silviculture in Europe*. Oxford University Press.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-Applied Forest Ecology*. John Wiley & Sons.

Smith DM. 1980. *The Practice of Silviculture*. 8th Ed. USED.

Zobel BJ, Wyk G & Stahlper P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FOR 607 ADVANCES IN FOREST REPRODUCTIVE BIOLOGY 1+1 SEM - I

Objective

To develop understanding of students about phenology, phenodynamics breeding behaviour pollination biology and breeding systems in forest trees.

Theory

UNIT-I: Reproductive biology of gymnosperms and angiosperms, Reproduction and population genetic structure, population dynamics. Floral morphology, floral initiation and breeding systems. Flowering manipulation. Reproductive abnormalities.

UNIT-II: Pollination, biology, pollination ecology of tropical and temperate forest tree species, plant-pollination interactions. Pollinator energetic and nectar production

UNIT-III: Genetic consequences of variation in reproductive biology. Pollen biotechnology for improved production.

UNIT-IV: Gene expression during pollen development. Pollination efficiency of insects. Self-incompatibility.

Practical

Phenological studies in forest trees, nectar collection and analysis, pollination trapling distances, foraging behaviour, pollinator identification and visitation.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*. FAO Publ.

Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ.

Mandal AK & Gibson GL.(Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Foreste*. John Wiley & Sons.

FOR 608 ADVANCES IN AGROFORESTRY RESEARCH AND MANAGEMENT 2+0 SEM - I

Objective

To teach how to refine the Agroforestry systemsô management practices and their integration for developing suitable Agroforestry systems.

Theory

UNIT-I: Recent trends in Agroforestry research and development. Agroforestry land use systems and their salient features.

UNIT-II: Study of systems specification, prioritizing potential interventions and technology specifications; space and time related considerations.

UNIT-III: Introduction to on farm and on station research experiments. Factors affecting biomass production.

UNIT-IV: Soil-site sustainability and environmental resource sharing. Site-Species compatibility. Competition predation, mutualism, commensalisms. Simulation modeling of Agroforestry systems.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

DEFICIENCY COURSES FOR NON FORESTRY GRADUATES

FOR 451 PRINCIPLE AND PRACTICES OF SILVICULTURE 2+0 SEM - I

Objective

To acquaint the students about general principles and practices of silviculture in India with examples of important trees.

Theory

UNIT-I: Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT-II: Site factors - climatic, edaphic, physiographic, biotic and their interactions. Classification of climatic factors. Role played by light, temperature, rainfall, snow, wind, humidity and evapo-transpiration in relation to forest vegetation.

UNIT-III: Physiographic factors - influence of altitude, latitude, aspect and slope on vegetation. Biotic factors - influence of plants, insects, wild animals, man and domestic animals on vegetation. Impacts of controlled burning and grazing. Influence of forests on environment.

UNIT-IV: Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices.* Oxford & IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors.

Khanna L. 1996. *Principles and Practices of Silviculture*. International Book Distr.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-applied Forest Ecology*. John Wiley & Sons.

FOR 452 FOREST MENSURATION 1+1 SEM - I

Objective

To acquaint the students about measurements of growth, wood production, biomass production and forest inventory.

Theory

UNIT-I: Introduction, definition, objectives and scope of forest mensuration. Scales of measurement (nominal, ordinal, interval and ratio scale). Units of measurement, standards of accuracy implied in their expression.

UNIT-II: Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes.

UNIT-III: Bark measurements - objectives, thickness, surface area and volume. Crown measurements - objectives, diameter, height, surface area and volume. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Measurement of cross sectional area, basal area, bole surface area, leaf area. The tree stem form, taper and classification of form factors and form quotient.

UNIT-IV: Volume estimation of felled and standing trees and formulae involved. Volume tables-definition and their classification, (general, regional and local volume tables), merchantable volume tables. Preparation of volume tables. Stand growth, site quality, site index, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees.

UNIT-V: Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables.

UNIT-VI: Forest inventory- definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry.

Practical

Units of measurement and their uses. Instruments used in forest mensuration and their working principles, pertaining to tree height, diameter, basal area, bark thickness and crown measurements. Measurement of bark thickness, bark volume, bark area and crown parameters. Volume estimation of logs, felled trees and standing trees. Preparation of volume tables, volume estimation of forest stands. Stump analysis and increment boring. Determination of age of standing trees. Calculation of CAI and MAI. Sampling exercises including Point sampling. Calculation of crop diameter, crop height and crop volume. Estimation of form factor. Estimation of canopy density. Use of aerial photographs in forest inventory. Study of different satellite images and their application in forestry.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributors.

Ram Parkash 1983. *Forest Surveying*. International Book Distributors.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 453 PRINCIPLES OF TREE IMPROVEMENT 1+1 SEM - I

Objective

To acquaint the students about basic concepts and general principles of tree improvement.

Theory

UNIT-I: Introduction, history and development of tree improvement, its relation to other disciplines for forest management. Reproduction in forest trees ï anthesis and pollination ï their importance in tree breeding.

UNIT-II: Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees.

UNIT-III: Genetic basis of tree breeding and selection practices in forest trees. Patterns of environmental variation- species and provenance trials in forest trees. Seed stands (seed production areas) Plus tree selection, progeny trials and establishment of seed orchard.

UNIT-IV: Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for specific purposes.

UNIT-V: Conservation of forest tree germplasm. Recent techniques in tree improvement. Vegetative propagation and tree improvement.

Practical

Floral biology and phenological observations in some important species. Estimation of pollen sterility and viability. Emasculation & hybridization in self pollinated species. Emasculation & hybridization in cross pollinated species. Different breeding methods-flow chart. Species and provenance selection techniques. Recording observation in provenance trial of some important species-recording variation & working out coefficient of variation. Sampling in seed collection. Recording stand density in seed stands, seed output; season of seed collection. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus-tree selection. Seed orchard designs. Recording the design and observations in teak, Eucalyptus seed orchards. Genetic engineering techniques in tree improvement.

Suggested Readings

Burley J & Styles BT. 1976. *Tropical Trees: Variation, Breeding and Conservation.* Academic Press.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

White JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talber J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

FOR 454 WOOD PRODUCTS AND UTILIZATION 1+1 SEM - I

Objective

To acquaint the students about various wood products, availability of raw material and best utilization practices in India.

Theory

UNIT-I: Pulp and paper industry. Introduction and raw material; pulping mechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and

sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT-II: Manufacture, properties and uses of Composite wood- plywood, fiber board, particle board and hard board.

UNIT-III: Adhesives used in manufacture of composite wood. Improved wood definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood. Production of wood molasses, alcohol and yeast.

Practical

Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR Publ.

Anonymous. 2007. *Year Book of Forest Products*. FAO.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

FOR 455 FOREST MANAGEMENT, POLICY AND LEGISLATION 1+1 SEM - I

Objective

To acquaint the students about general principles of forest management, working plan, forest policies and forest legislation in India.

Theory

UNIT-I: Introduction: definition and scope. Peculiarities of forest management. Principles of forest management and their applications. Objects of management, purpose and policy. Sustained and progressive yield concept and meaning. General definitions ï management and administrative units, felling cycle, cutting section.

UNIT-II: Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Normal forest: definition and concept. Even aged and uneven aged models. Estimation of growing stock, density, quantity and increment.

UNIT-III: Yield regulation ï general principles of even aged and uneven aged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees.

UNIT-IV: Working Plan ï definition, objects and necessity. Forest Policy: definition, necessity and scope.

UNIT-V: Legal and institutional approaches to forest resource management. National Forest Policies. Forest Law: legal definition. Objects of special forest law. Indian Forest Act. Detailed study of IFA, 1927.

Practical

Visit to plantations of different age gradations, record the actual growing stock and workout increments. Visit to forests and enumerate the stock and test one of the method for yield regulation. Study the various units adopted in the forest management. Study of various records and forms maintained in the office of the RFO with regard to management of forests under their control. Study of procedure for seizure of property. Visit to forest department and courts to observe penalty procedures. Preparation of first information report and enactment report. Study of working plans of the forests and to prepare the working plan for one of the area in the range.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributors.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

National Forest Policy 1988. Ministry of Environment and Forests. Govt. of India.

Ram Prakash 1986. *Forest Management*. International Book Distributors.

FORESTRY

List of Journals

- ***Agroforestry Systems*** (Kluwer Academic Publishers, The Netherlands).
- ***European Journal of Forest Pathology*** (Kluwer Academic Publishers, The Netherlands).
- ***Forest Ecology and Management*** (Kluwer Academic Publishers, The Netherlands).
- ***Forest Genetic Resources*** (FAO)
- ***Indian Forester*** (ICFRE, Dehradun).
- ***Indian Journal of Agroforestry*** (NRCAF, Jhansi).
- ***Indian Journal of Forestry*** (M/s Bishen Singh Mahender Pal Singh, 23-A, Connaught Place, Dehradun)
- ***Journal of Tree Sciences*** (Indian Society of Tree Scientists, Dr. Y. S. Parmar University of Horticulture and Forestry, P.O.: Nauni, Solan).
- ***Myforest*** (Karnataka Forest Department, Bangalore-560003).
- ***Silvae Genetica*** (Institute for Forest Genetics and Tree Breeding, Germany).
- ***Tree Physiology*** (Kluwer Academic Publishers, The Netherlands)
- ***Unasyla*** **(**FAO).
- ***Wood Science and Technology*** (Springer-Verlag).

e-Resources

- www.hau.ernet.in/ejournals.htm
- www.manage.gov.in/managelib/onlinejrnls.htm
- www.gbpuat.ac.in/acads/cfor/index.htm
- www.uasbangalore.edu.in
- www.kuvempu.ac.in/libraryweb/lib-cjour.htm
- www.clickindia.com
- www.gbpihed.nic.in/library/catalog.htm
- www.tnau.ac.in/lib/libej.html
- www.ames.lib.umn.edu/dalenv.phtml
- www.elibrary.icrisat.org/
- www.icfre.org
- www.ias.ac.in
- www.hmlibrary.ac.in
- www.yspuniversity.ac.in/library/library-int.htm
- www.du.ac.in/du/achievementsoftheyear07.pdf
- www.andhrauniversity.info/inaugurationmessage.html
- www.elsevier.de/ufug.
- www.btisnet.nic.in/wordfiles/E-Journal.doc
- www.teriin.org/
- www.icar.org.in
- www.knowledgecommission.gov.in
- www.mail.iari.res.in/library
- www.lib.iastate.edu/collections/eresourc/ag-for-toc.html
- www.wood-report.de
- www.geocities.com/utmfc/forestry_links.htm
- www.bfw.ac.at
- www.donnelly.nmhu.edu/articles/databases.asp?subject=Forestry
- www.ucd.ie/library/electronic_resources/e-lib/forestry.html
- www.cabi.org

Suggested Broad Topics for Master's and Doctoral Research

- Breeding for biotic and abiotic stresses in important tree species
- Domestication and breeding of unexploited tree/shrub species
- Epidemiology and management of tree diseases in nursery and plantations

- Etiology and management against tree decline/mortality
- Problems and management of insect-pests and nematodes in forest tree species
- Studies on biomass production, nutrient cycling and carbon sequestration in different agroforestry systems
- Studies on above and below ground interactions in different agroforestry systems
- Studies on phytoremediating potential of different tree species
- Identification of tree species for biodrainage in reclamation of waterlogged areas
- Use of conventional breeding, biotechnology and mutation breeding in development of fast growing and transgenic trees for short rotation agroforestry systems
- Genetic improvement and development of short statured, early bearing and high seed yielding genotypes in different tree borne oilseeds (TBOs)
- Agroforestry systems and their effects on sustainable productivity

GENETICS AND PLANT BREEDING

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
GP501*	PRINCIPLES OF GENETICS	2+1	I
GP 502*	PRINCIPLES OF PLANT BREEDING	2+1	I
GP 503	PRINCIPLES OF CYTOGENETICS	2+1	II
GP 504	POPULATION GENETICS	2+1	I
GP 505*	PRINCIPLES OF QUANTITATIVE GENETICS	2+1	II
GP 506	MUTAGENESIS AND MUTATION BREEDING	2+1	I
GP 507	HETEROSIS BREEDING	2+1	II
GP 508	GENE REGULATION AND EXPRESSION	2+0	I
GP 509	CELL BIOLOGY AND MOLECULAR GENETICS	3+0	II
GP 510*	BIOTECHNOLOGY FOR CROP IMPROVEMENT	3+1	I
GP 511*	BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE	2+1	II
GP 512	BREEDING CEREALS, FORAGES AND SUGARCANE	2+1	I
GP 513	BREEDING LEGUMES, OILSEEDS AND FIBRE CROPS	2+1	II
GP 514	BREEDING FOR QUALITY TRAITS	2+1	I
GP 515	MAINTENANCE BREEDING, CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION	1+1	II
GP 516	GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE	2 +1	I
GP 517/ SST 516 ❶	DATA BASE MANAGEMENT, EVALUATION AND UTILIZATION OF PGR	2+1	II
GP 518/ PSMA 505 ❷	BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1	II
GP 591	MASTERôS SEMINAR	1	I, II
GP 599	MASTERôS RESEARCH	20	I, II
GP 601	ADVANCED GENETICS	2+0	I
GP 602	CELLULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING	2+0	II
GP 603	ADVANCED BIOMETRICAL AND QUANTITATIVE GENETICS	2+1	I
GP 604	GENOMICS IN PLANT BREEDING	2+1	II
GP 605	PLANT GENETIC RESOURCES AND PRE-BREEDING	2+0	I
GP 606	ADVANCES IN PLANT BREEDING SYSTEMS	2+0	II
GP 607	CROP-EVOLUTION	2+0	I
GP 608**	BREEDING DESIGNER CROPS	2+1	II
GP 609**	ADVANCES IN BREEDING OF MAJOR FIELD CROPS	3+0	I
GP610/ SST 602 ❸	*IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM	2 +1	II
GP 611	MICROBIAL GENETICS	2+1	I
GP 612/ PSMA 605 ❹	ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1	II
GP 691	DOCTORAL SEMINAR I	1	I, II
GP 692	DOCTORAL SEMINAR II	1	I, II
GP 699	DOCTORAL RESEARCH	45	I, II

*Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

❶ ❷ ❸ ❹ To be taught by Genetics and Plant Breeding

GENETICS AND PLANT BREEDING

Course Structure

GP 501 PRINCIPLES OF GENETICS 2+1 SEM - I

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 Mendelôs paper; Chromosomal theory of inheritance; Multiple alleles; Gene interactions; Sex determination, differentiation and sex-linkage; Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes; Somatic cell genetics; Extra chromosomal inheritance; Male sterility and incompatibility.

UNIT-II: Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Recombination in bacteria, fungi, viruses; Tetrad analysis; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis; Genetic fine structure analysis; Allelic complementation, Split genes; Transposable genetic elements; Overlapping genes, Pseudogenes, Oncogenes; Gene families and clusters.

UNIT-III: 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; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification; Gene isolation, synthesis and cloning; genomic and cDNA libraries; PCR based cloning, positional cloning; Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

UNIT-IV: Genomics and proteomics; Functional and pharmacogenomics; Metagenomics; Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; Genetics of mitochondria and chloroplasts.

UNIT-V: Population- Mendelian population, random mating population; Frequencies of genes and genotypes- causes of change; Hardy-Weinberg equilibrium; Concepts of Eugenics, Epigenetics; Genetic disorders and Behavioural genetics; Overview of recent discoveries in the field of genetics.

Practical

Laboratory exercises on probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Pedigree analysis in humans, Problems on HWE, Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification -Electrophoresis ï basic principles and running of amplified DNA -Extraction of proteins and isozymes; Visit to experimental farm, glasshouse and learning some practical considerations.

Suggested Readings:

Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.

Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu.

Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.

Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.

Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons.

Strickberger MW. 2005. Genetics. 3rd Ed. Prentice Hall.

Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.

Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU, Hisar.

GP 502 PRINCIPLES OF PLANT BREEDING 2+1 SEM - I

Objective

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: 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, clonal selection.

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 breedersô rights 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.

Suggested Readings

Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.

Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.

Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.

Gupta SK. 2005. *Practical Plant Breeding*. Agribios.

Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.

Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.

Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.

Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.

Singh BD. 2006. *Plant Breeding*. Kalyani.

Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani.

Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.

Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*. CBS.

GP 503 PRINCIPLES OF CYTOGENETICS 2+1 SEM - II

Objective

To provide insight into structure and functions of chromosomes, chromosome 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: Chromosomal theory of inheritance ï Cell Cycle and cell division ï mitosis and meiosis, Differences , significance and deviations ï Synapsis, structure and function of

synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and 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 ï 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 ï - Role of aneuploids in basic and applied aspects of crop breeding; their maintenance and utilization in gene mapping and gene blocks transfer ï Alien addition and substitution lines ï creation and utilization; Apomixis: Evolutionary and genetics 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) ï 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 postfertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops, Chromosome manipulations in wide hybridization ; case studies ï 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 alloploy ploids - 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

Suggested Readings

Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.

Carroll M. 1989. *Organelles*. The Guilford Press.

Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall.

Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen & Unwin Ltd.

Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press.

Gray P. 1954. *The Mirotomist's Formulatory Guide*. The Blakiston Co.

Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding and Evolution*. Part A. Elsevier.

Gupta PK. 2000. *Cytogenetics*. Rastogi Publ.

Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.

Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.

Khush GS, 1973 *Cytogenetics of Aneuploids*. Academic Press.
Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth.
Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.
Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

GP 504 POPULATION GENETICS 2+1 SEM - I

Objective

To impart knowledge on structure, properties of equilibrium population, forces influencing gene and genotypic frequencies, breeding values of different population, average effects of gene substitution and correlation between relatives.

Theory

UNIT-I: Concepts of population, properties of population; Role of population genetics; Mendelian population: Genetic constitution of a population through time, space, age structure etc.; Probability rules in relation to Mendelian inheritance; Mating systems: Random mating population; Frequencies of genes and genotypes: causes of change (population size, differences in fertility and viability), migration and mutation; Natural, idealized and non-idealized population.

UNIT-II: Hardy-Weinberg Equilibrium: Proof and applications of the Hardy-Weinberg law; Hardy-Weinberg law: Single locus with two allele and multiple alleles; Sex linked genes; Forces affecting gene frequencies and equilibrium; Mean of random mating population: dominance, no-dominance and codominance cases; Wahlundôs principle; Snyderôs ratio; Gene substitution and average effects; Breeding value: effect of random mating in succeeding generations.

UNIT-III: Fisherôs theorem of natural selection, Migration, Mutation, Recurrent and non recurrent selection; Balance between selection and mutation, Selection favouring heterozygotes, Over dominance for fitness; Genetic equilibrium for multiple loci; Linkage disequilibrium; Polygenes and continuous variation, components of variation; Covariances; Non- random mating, selfing, back crossing; Inbreeding coefficient, panmictic index, sib mating; Assortative mating and disassortative mating; Pedigree populations and close inbreeding.

UNIT-IV: Correlation between relatives and estimation of F; Effect of inbreeding and sibling in cross pollinated crops; Theory of path and regression in applied population genetics; Genetic drift; Genetic slippage, Co-adapted gene complexes; Homoeostasis, adaptive organization of gene pools; Polymorphism, balanced and non-balanced polymorphism, heterozygous advantage; Survival of recessive and deleterious alleles in populations; Founders principle; Equilibrium in autopolyploidy; Generalized zygotic distribution and meiotic drive; Electrophoretic variants of proteins and molecular approach in the study of population.

Practical

Genetic exercise on probability**;** Estimation of gene frequencies; Exercises on factors affecting gene frequencies; Estimation of average affect of gene substitution and breeding value; Exercises on inbreeding and linkage disequilibrium.

Suggested Readings

Chawla V & Yadava RK. 2006. *Principles of Population Genetics – A Practical Manual*. Dept. of Genetics, CCS HAU, Hisar.
Falconer DS & Mackay J. 1996. *Introduction to Quantitative Genetics*. Longman.
Jain JP & Parbhakaran,VT. 1992. *Genetics of Populations*. South Asian Publications.
Li CC. 1955. *Population Genetics*. The Univ. of Chicago Press.
Mather K & Jinks JL. 1982. *Biometrical Genetics*. Chapman & Hall.
Sorrens D & Doniel G. 2007. *Methods in Quantitative Genetics*. Series: *Statistics for Biology and Health*. Likelihood.
Tomar SS. 1992. *Text Book of Population Genetics*. Universal Publication.

GP 505 PRINCIPLES OF QUANTITATIVE GENETICS 2+1 SEM - II

Objective

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 Anaylis 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 ï principles and applications - Genetic diversity analysis ï 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 abilityand gene actionï - Analysis of genotype x environment interaction - adaptability and stability, Models for GxE analysis and stability parameters - AMMI analysis ï principle 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 Aided 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: Griffingôs method I - Diallel analysis: Griffingôs method II - Diallel analysis: Haymanôs graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis : statistical part - Line x tester analysis: interpretation of 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, environment 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 population and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) ï - 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.

Suggested Readings

Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.

Falconer DS. 1983. *Problems on Quantitative Genetics*. Longman.

Falconer DS. 1998. *Introduction to Quantitative Genetics*. Longman.

Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.

Mather K & Jinks J L. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.

Naryanan SS and Singh P . 2007. *Biometrical Techniques in Plant* Breeding. Kalyani.

Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 506 MUTAGENESIS AND MUTATION BREEDING 2+1 SEM - I

Objective

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made .

Theory

UNIT-I: Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations - Detection of mutations in lower and higher organisms ï paramutations

UNIT-II: Mutagenic agents: physical -- Radiation types and sources: Ionising and non-ionizing radiations *viz*., X rays, ɔ rays, , and ɓ particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (, photoelectric absorption, Compton scattering and pair production) and their biological effects ï RBE and LET relationships

UNIT-III*:* Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects - Dosimetry - Objects and methods of treatment - Factors influencing mutation: dose rate, acute *vs* chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: external and internal sources- oxygen, water content, temperature and nuclear volume

UNIT-IV: Chemical mutagens- Classification - base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens - combination treatments ; Other causes of mutation: direct and indirect action, comparative evaluation of physical and chemical mutagens.

UNIT-V: Observing mutagen effects in M_1 generation: plant injury, lethality, sterility, chimeras *etc*., - Observing mutagen effects in M_2 generation - Estimation of mutagenic efficiency and effectiveness ï spectrum of chlorophyll and viable mutations -ï Mutations in traits with continuous variation.

UNIT-VI: Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc*. - Individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation - Comparative evaluation of physical and chemical mutagens for creation of variability in a same species ï case studies.

UNIT-VII: Use of mutagens in creating oligogenic and polygenic variations ï case studies - In vitro mutagenesis ï callus and pollen irradiation - - Handling of segregating genrations and selection procedures- Validation of mutants- Mutation breeding for various traits (disease resistance, insect resistance, quality improvement,etc) in different crops -ï , ï Procedures for micro-mutations breeding/polygenic mutations, Achievements of mutation breeding: varieties released across the world-Problems associated with mutation breeding.

UNIT-VIII: Use of mutagens in genomics, allele mining, TILLING.

Practical

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity ï production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring ï safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagules at different doses of physical and chemical mutagens - Learning combined mutagenic treatments ; raising the crop for observation - Mutagenic effectiveness and efficiency ; calculating the same from earlier literature - Study of M1 generation ï parameters to be observed - Study of M2 generation ï parameters to be observed - Mutation breeding in cereals and pulses ï achievements made and an analysis - Mutation breeding in oilseeds and cotton ï achievements and opportunities - Mutation breeding in forage crops and vegetatively propagated crops. Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

Suggested Readings

Alper T. 1979. *Cellular Radiobiology*. Cambridge Univ. Press, London.

Chadwick KH & Leenhouts HP. 1981. *The Molecular Theory of Radiation Biology*. Springer-Verlag.

Cotton RGH, Edkin E & Forrest S. 2000. *Mutation Detection: A Practical Approach*, Oxford Univ. Press, USA.

International Atomic Energey Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energey Agency, Vienna, Italy.

Singh BD. 2003. *Genetics*. Kalyani.

Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall.

GP 507 HETEROSIS BREEDING 2+1 SEM - II

Objective

To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

Theory

UNIT-I: Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and bred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops crops.

UNIT-II: Pre Mendelian and Post Mendelian ideas - Genetic theories of heterosis ï Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis.

UNIT-III: Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis ï case studies. - Relationship between genetic distance and expression of heterosis ï case studies; Divergence and Genetic Distance analyses-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 types of male sterility. Use of self-incompatibility in development of hybrids. Hybrid seed production system: 3-line, 2-line and 1-line system, Development of inbreds and parental lines- A, B and R lines ï functional male sterility, Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.

UNIT-V: Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops - Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated crops ï problems and prospects, Apomixis in fixing heterosis-concept of single line hybrid.

UNIT-VI: Organellar heterosis and complementation - Creation of male sterility through genetic engineering and itsexploitation in heterosis.

UNIT-VII: Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical

Male sterile line characterization in millets ; using morphological descriptors ; restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters -Hybrid seed production in field crops ï an account on the released hybrids; their potential ; problems and ways of overcoming it; hybrid breeding at National and International level ; opportunities ahead.

Suggested Readings

Abstracts of the Genetics and Exploitation of Heterosis in Crops - An International Symposium CIMMYT.

Akin E. 1979. *The Geometry of Population Genetics*. Springer-Verlag.

Ben Hiu Lin. 1998. *Statistical Genomics – Linkage, Mapping and QTL Analysis*. CRC Press.

De Joung G. 1988. *Population Genetics and Evolution*. Springer-Verlag.

Hartl DL. 2000. *A Primer of Population Genetics*. 3rd Ed. Sinauer Assoc.
Mettler LE & Gregg TG. 1969. *Population Genetics and Evolution*. Prentice Hall.
Montgomery DC. 2001. *Design and Analysis of Experiments*. 5th Ed., Wiley & Sons.
Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.
Srivastava S & Tyagi R. 1997. *Selected Problems in Genetics*. Vols. I, II. Anmol Publ.

GP 508 GENE REGULATION AND EXPRESSION 2+0 SEM - I

Objective

To provide insight into recent advances in the phenomenon of gene regulation and mechanisms by which plants and microbes express different traits and how these are modified during different stages.

Theory

UNIT-I: Introduction: Gene regulation; Process and mechanisms in prokaryotes and eukaryotes; Levels of gene controls.

UNIT-II: Coordinated genetic regulation-examples; Anthocyanin and gene families in maize; Genetic and molecular basis depending on tissue specificity.

UNIT-III: Regeneration in plants and animals; Chromatin and nuclear proteins, chromosomal differentiation, nucleo-cytoplasmic interactions; long lived mRNA; differentiation in *Acetabularia;* morphogenesis in viruses and bacteria.

UNIT-IV: Gene expression; Transposons in plant gene expression, cloning, transposon tagging; Light regulated gene expression: Model systems in *Arabidopsis* and maize; Paramutations and imprinting of genes and genomes.

UNIT-V: Repeated DNA sequences; hormone induced cellular functions in plants and animals; double fertilization; embryo and endosperm development; Tissue differentiation and pattern formation; homeotic genes; Seed storage protein synthesis;

UNIT-VI: Transgene expression and gene silencing mechanisms; Regulatory genes horizontal and vertical homology; Transformation: Regulatory genes as visible markers; Reporter systems to study gene expression; Combinatorial gene control.

UNIT-VII: Eukaryotic transcriptional control; Translational and post-translational regulation; Signal transduction; Stress-induced gene expression; Gene traps and enhancer traps.

Suggested Readings

Brooker RJ. 2004. *Genetics Analysis and Principles*. Addison-Wesley Longman.
Brown TA. 2002. *Genomes.* Bios Scientific.
Griffiths AJF. 2000. *An Introduction to Genetic Analysis*. WH Freeman.
Hartl DL & Jones EW. 1998. *Genetics Principles and Analysis*. Jones & Barlett.
Hexter W & Yost HT. 1976. *The Science of Genetics*. Prentice Hall.
Lewin B. 2008. *Genes IX*. John Wiley & Sons.
Micklos DA & Freyer G. 2003. *DNA Science - A First Course*. CPL Scientific.
Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific.
Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley.
Singer M & Berg P. 1991. *Genes and Genomes*. John Wiley & Sons.
Tamarin RH. 1999. *Principles of Genetics*. Wm C Brown.
Watson JD. 2004. *Molecular Biology of the Gene*. Pearson Edu.

GP 509 CELL BIOLOGY AND MOLECULAR GENETICS 3+0 SEM - II

Objective

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Theory

UNIT-I: History and scope: Theory of cell differentiation - Genome constancy - indirect and direct evidences for differential gene expressions,

UNIT-II: Genome control in embryogenesis; Maternal control in early development, Gene amplification; Localization and molecular mechanisms of morphogenetic determinants in egg cytoplasms; Determination, transdetermination.

UNIT-III: 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-IV: 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-V: Transposable elements; Mechanisms of recombination in prokaryote; 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; Genes in development; Cancer and cell aging.

Suggested Readings

Bruce A.2004. *Essential Cell Biology*. Garland.

Darell J, Harvey L& Baltimore D. 2004. *Molecular Cell Biology*. WH Freeman.

Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.

Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.

Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.

Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.

Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman.

Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.

Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.

GP 510 BIOTECHNOLOGY FOR CROP IMPROVEMENT 3+1 SEM - I

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: Genotyping; sequencing techniques; Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F_2s, back crosses, RILs, NILs and DH).

UNIT-IV: Molecular mapping and tagging of agronomically important traits.Statistical tools in marker analysis, Robotics, 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,

UNIT-VI: Recombinant DNA technology, transgenes, method of gene transformations, 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 release

UNIT-VII: Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT-VIII: MOs 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-IX: Bioinformatics & Bioinformatics tools.

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 ï interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; standardizing the protocols for regeneration; Hardening of regenerated plants; establishing a screenhouse 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.

Suggested Readings

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation.* 2nd Ed. Benjamin Publ. Co.

Sambrook J and Russel D. 2001. *Molecular Cloning*-a LABOTATORY Manual (III Ed) Cold Spring Harbor Lab. Press, USA.

Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

GP 511 BREEDING FOR BIOTIC, ABIOTIC STRESS RESISTANCE 2+1 SEM - II

Objective

To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

Theory

UNIT-I: Importance of plant breeding with special reference to biotic and abiotic stress resistance, Classification of biotic stresses ï major pests and diseases of economically important crops - Concepts in insect and pathogen resistance ; analysis and inheritance of resistance variation. Host defence responses to pathogen invasions-biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT-II: Types and genetic mechanisms of resistance to biotic stresses ï horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and; molecular breeding methods - Measuring plant resistance using plant fitness, behavioural, physiological and insect gain studies.

UNIT-III: Phenotypic screening methods for major pests and diseases; recording of observations; correlating the observations using marker data - Gene pyramiding methods and their implications.

UNIT-IV: Classification of abiotic stresses - Stress inducing factors ï moisture stress/drought and water logging & submergence; acidity, salinity/alkalinity/sodicity; high/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT-V: Genetics of abiotic stress resistance, Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures. Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc. Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT-VI: Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitenases and Bt for diseases and insect pest management- achievements.

Practical

Phenotypic screening techniques for sucking pests and chewing pests ï traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers ; ways of combating them; breeding strategies - Weeds ï ecological, environmental impacts on the crops; breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance ; use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity; their effects and breeding strategies - Understanding the climatological parameters and predisposal of biotic and abiotic stress factors; ways of combating them.

Suggested Readings

Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC Press.

Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley International.

Fritz RS & Simms EL. (Eds.). 1992. *Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics*. The University of Chicago Press.

Li PH & Sakai A. 1987. *Plant Cold Hardiness*. Liss, New York

Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of Controlling Insects*. USDA, ARS, Washington DC.

Maxwell FG & Jennings PR. (Eds.). 1980. *Breeding Plants Resistant to Insects*. John Wiley & Sons.

Painter RH. 1951. *Insect Resistance in Crop Plants*. MacMillan, New York.

Russel GE. 1978. *Plant Breeding for Pest and Disease Resistance*. Butterworths.

Sakai A & Larcher W. 1987. *Frost Survival in Plants*. Springer-Verlag.

Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

van der Plank JE. 1982. *Host-Pathogen Interactions in Plant Disease*. Academic Press.

GP 512 BREEDING CEREALS, FORAGES AND SUGARCANE 2+1 SEM - I

Objective

To provide insight into recent advances in improvement of cereals and forage crops and sugarcane using conventional and modern biotechnological approaches.

Theory

UNIT-I: Rice: evolution and distribution of species and forms - wild relatives and germplasm - Rice: genetics ï cytogenetics and genome relationship - Breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc.* ï Hybrid rice breeding: potentials and outcome - Aerobic rice; its implications and drought resistance breeding.

UNIT-II: Wheat: evolution and distribution of species and forms - wild relatives and germplasm ï cytogenetics and genome relationship - breeding objectives: yield, quality characters, biotic and abiotic stress resistance, exploitation of heterosis *etc* - Sorghum: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc* - Pearl millet: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc.

UNIT-III: Maize: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc* - Maize: QPM and Bt maize ï strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize - Minor millets: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Minor millets: breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc* - Sugarcane: evolution and distribution of species and forms - wild relatives and germplasm.

UNIT-IV: Sugarcane: cytogenetics and genome relationship - Sugarcane: breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc* - Forage grasses: evolution and distribution of species and forms - Forage grasses: Wild relatives and germplasm - cytogenetics and genome relationship - Forage grasses: breeding objectives: yield, quality characters and palatability studies - Forage grasses: biotic and abiotic stress resistance etc., synthetics, composites and apomixes.

UNIT-V: Forage legumes: evolution and distribution of species and forms - Forage legumes : wild relatives and germplasm - cytogenetics and genome relationship - Forage legumes: breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc* - Tree fodders: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Tree fodders: breeding objectives: yield, quality characters, biotic and abiotic stress resistance *etc*, palatability studies.

UNIT-VI: Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearl millet, Maize and other millets - Sugarcane, forage grasses and legumes and their application to DUS testing - Maintenance of seed purity - Nucleus and Breeder Seed Production.

Practical

Floral biology ï emasculation - pollination techniques ; Study of range of variation for yield and yield components ï study of segregating populations - evaluation - Trait based screening for stress resistance in crops of importanceï Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; use of softwares for database management and retrieval.Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability - Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories, learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

Suggested Readings

Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford & IBH.

Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.

Chandraratna MF. 1964. *Genetics and Breeding of Rice*. Longmans.

Chopra VL & Prakash S. 2002. *Evolution and Adaptation of Cereal Crops*. Oxford & IBH.

Gill KS. 1991. *Pearl Millet and its Improvement*. ICAR.

IRRI. 1964. *Rice Genetics and Cytogenetics*. Elsevier.

IRRI. 1986. *Rice Genetics*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 1991. *Rice Genetics II*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 1996. *Rice Genetics III*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 2000. *Rice Genetics IV*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

Jennings PR, Coffman WR & Kauffman HE. 1979. *Rice Improvement*. IRRI, Los Banos, Manila, Philippines.

Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture*. Directorate of Extension Education, TNAU, Coimbatore.

Murty DS, Tabo R & Ajayi O. 1994. *Sorghum Hybrid Seed Production and Management*. ICRISAT, Patancheru, India.

Nanada JS. 1997. *Manual on Rice Breeding*. Kalyani.

Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.

Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. *Crop Breeding in India*. International Book Distributing Co.

Slafer GA. (Ed.). 1994. *Genetic Improvement of Field Crops*. Marcel Dekker.

Walden DB. 1978. *Maize Breeding and Genetics*. John Wiley& Sons.

GP 513 BREEDING LEGUMES, OILSEEDS AND FIBRE CROPS 2+1 SEM - II

Objective

To provide insight into recent advances in improvement of legumes, oilseeds and fibre crops using conventional and modern biotechnological approaches.

Theory

UNIT-I: Pigeonpea: evolution and distribution of species and forms - wild relatives and germplasm - genetics - cytogenetics and genome relationship; morphological and molecular descriptors used for differentiating the accessions - breeding objectives: yield, quality characters, biotic and abiotic stress *etc* - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

UNIT-II: Chickpea: Evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress etc. Protein quality improvement ï conventional and modern plant breeding approaches, progress made - Breeding for anti nutritional factors.

UNIT-III: Other pulses: Greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, lablab, mothbean: ï evolution, cytogenetics and genome relationship, learning the descriptors -

breeding objectives: yield, quality characters, biotic and abiotic stress *etc* - - interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT-IV: Groundnut: evolution and distribution of species and forms - Groundnut : wild relatives and germplasm - cytogenetics and genome relationship; pod and kernel characters - Groundnut: breeding objectives: yield, quality characters, biotic and abiotic stress *etc*.

UNIT-V: Rapeseed and Mustard: breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality ï characteristics in different oils -evolution and distribution of species and forms - wild relatives and germplasm - genetics - cytogenetics and genome relationship.

UNIT-VI: Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality ï characteristics - evolution and distribution of species and forms - wild relatives and germplasm - genetics - cytogenetics and genome relationship.

UNIT-VII: Other oilseed crops: Sunflower,sesame, safflower, niger, : evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - breeding objectives: yield, quality characters, biotic and abiotic stress - Sunflower: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

UNIT-VIII: Castor: evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress *etc* - Hybrid breeding in castor ï opportunities, constraints and achievements.

UNIT-IX: Cotton: evolution of cotton, breeding objectives: yield, quality characters, biotic and abiotic stress etcï Cotton: Development and maintenance of male sterile lines ï Hybrid development and seed production ï Scenario of Bt cottons, evaluation procedures for Bt cotton - Jute: evolution and distribution of species and forms - wild relatives and germplasm ï cytogenetics and genome relationship-Jute: breeding objectives: yield, quality characters, biotic and abiotic stress *etc* - Mesta and minor fibre crops: evolution and distribution of species and forms ï wild relatives and germplasm - cytogenetics and genome relationship ï Mesta and minor fibre crops: breeding objectives: yield, quality characters, biotic and abiotic stress etc.

UNIT X: Distinguishing features of the released varieties in pulses, oilseeds and cotton ; Maintenance of seed purity and seed production.

Practical

Use of descriptors for cataloguing ï Floral biology - emasculation ï pollination techniques; Study of range of variation for yield and yield components - study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops. Attempting crosses between Blackgram and Greengram. Use of descriptors for cataloguing ï Floral biology - emasculation ï pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: use of descriptors for cataloguing ï Floral biology - emasculation ï pollination techniques; learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fibre quality evaluation ï conventional and modern approaches; analysing the lint samples of different species, interspecific and interracial derivatives for fibre quality and interpretation ï Cotton: Development and maintenance of male sterile lines Evaluation of cotton cultures of different species for insect and disease resistance ï learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters ï learning the procedures on development of Bt cotton - Visit to Cotton Technology Laboratory and Spinning Mills ï learning on cotton yarn production, its quality evaluation and uses.

Suggested Readings

Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford & IBH.

Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.

Chahal GS & Ghosal SS. 2002. *Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches*. Narosa Publ.

Chopra VL. 1997. *Plant Breeding*. Oxford & IBH.

Nath V & Lal C. 1995. *Oilseeds in India.* Westvill Publ. House.
Nigam J. 1996. *Genetic Improvement of Oilseed Crops*. Oxford & IBH.
Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.
Singh DP. 1991. *Genetics and Breeding of Pulse Crops*. Kalyani.
Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. *Crop Breeding in India*. International Book Distributing Co.
Smartt J. 1994. *The Groundnut Crop - a Scientific Basis for Improvement*. Chapman & Hall.

GP 514 BREEDING FOR QUALITY TRAITS 2+1 SEM - I

Objective

To provide insight into recent advances in improvement of quality traits in rice, millets, legumes, oilseeds and forage crops and for physiological efficiency using conventional and modern biotechnological approaches.

Theory

UNIT-I: Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, aminoacids and anti-nutritional factors - Nutritional improvement - A human perspective - Breeding for grain quality parameters in rice and its analysis - Golden rice and aromatic rice ï breeding strategies, achievements and application in Indian context - Molecular basis of quality traits and their manipulation in rice - Post harvest manipulation for quality improvement.

UNIT-II: Breeding for baking qualities in wheat; characters to be considered and breeding strategies - Molecular and cytogenetic manipulation for quality improvement in wheat - Breeding for quality improvement in barley and oats.

UNIT-III: Breeding for quality improvement in Sorghum and pearl millet; Quality protein maize ï concept and breeding strategies ï Breeding for quality improvement in forage crops - Genetic resource management for sustaining nutritive quality in crops.

UNIT-IV: Breeding for quality in pulses - Breeding for quality in groundnut, sesame, sunflower and minor oilseeds ï Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton.

UNIT-Vl: Genetic engineering protocols for quality improvement ï Achievements made - Value addition in crops; classification and importance - Nutritional genomics and Second generation transgenics.

Practical

Grain quality evaluation in rice; correlating ageing and quality improvement in rice - Quality analysis in millets ; estimation of antinutritional factors like tannins in different varieties/hybrids ; a comparison - Quality parameters evaluation in wheat; Quality parameters evaluation in pulses - Quality parameters evaluation in oilseeds - Value addition in crop plants ; Post harvest processing of major field crops - Quality improvement in crops through tissue culture techniques - Evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures.

Suggested Readings

Chahal GS & Ghosal SS. 2002. *Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches*. Narosa Publ.
Chopra VL. 1997. *Plant Breeding*. Oxford & IBH.
FAO 2001. *Speciality Rices of the World - Breeding, Production and Marketing*. Oxford & IBH.
Ghosh P. 2004. *Fibre Science and Technology*. Tata McGraw Hill.
Hay RK. 2006. *Physiology of Crop Yield*. 2nd Ed. Blackwell.
Nigam J. 1996. *Genetic Improvement of Oilseed Crops*. Oxford & IBH.
Singh BD. 1997. *Plant Breeding*. Kalyani.
Singh RK, Singh UK & Khush GS. 2000. *Aromatic Rices*. Oxford & IBH.

GP 515 MAINTENANCE BREEDING, CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION **1+1** **SEM - II**

Objective

To appraise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self and cross pollinated crops

Theory

UNIT-I: Variety Development and Maintenance - Define variety, cultivar,extant variety, essentially derived variety, independently derived variety, reference variety, farmersô variety, hybrid,and population; Variety testing, release and notification system in India and abroad.

UNIT-II: DUS testing- DUS Descriptors for major crops - genetic purity concept and maintenance breeding.

UNIT-III: Factors responsible for deterioration of varieties - safeguards during seed production; maintenance of varieties in self and cross-pollination crops- isolation distance; methods of nucleus and breeder seed production; principles of seed production.

UNIT-IV: Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - main characteristics of released and notified varieties, hybrids and parental lines; identification of important weeds/objectionable weeds; determination of isolation distance and planting ratios in different crops; seed production techniques of varieties in different crops; hybrid seed production technology of important crops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Department of Plant Breeding. CCS HAU Hisar.

Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA, Washington, DC.

Poehlman JM & Borthakur D. 1969. *Breeding Asian Field Crops*. Oxford & IBH.

Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.

Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.

Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR.

GP 516/ SST 516 GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE **2+1** **SEM - I**

Objective

To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants for crop improvement.

Theory

UNIT-I: History and importance of germplasm exploration; distribution and extent of prevalent genetic diversity; phyto-geographical regions/ecological zones and associated diversity; mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

UNIT-II: Concept of population and gene pool; variations in population and their classification; gene frequencies in populations, rare and common alleles; gene pool sampling in self and cross pollinated and vegetatively propagated species; non-selective, random and selective sampling strategies; strategies and logistics of plant exploration and

collection; coarse and fine grid surveys; practical problems in plant exploration; use of *in vitro* methods in germplasm collection.

UNIT-III: Ethnobotanical aspects of PGR; crop botany, farming systems, collecting wild relatives of crop plants; collection and preservation of specimens; importance and use of herbaria and preparation of herbarium specimens.

UNIT-IV: Post-exploration handling of germplasm collections; present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

UNIT-V: History, principles, objectives and importance of plant introduction; pre-requisites, conventions, national and international legislations and policies on germplasm collection and exchange; documentation and information management. Plant quarantine: introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; pest risk analysis, pest and pathogen information database; quarantine in relation to integrated pest management; economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

UNIT-VI: Detection and identification of pests including use of recent techniques like ELISA, PCR etc., symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; domestic quarantine; seed certification; international linkages in plant quarantine; weaknesses and future thrust.

UNIT-VII: Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment, Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety with GMOs.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys. Identification of wild relatives of crop plants; Example of collection, cataloguing and preservation of specimens. Sampling techniques of plant materials, visiting ports, airports to study the quarantine regulations. Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging, Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc), Detection of genetically engineering Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

Suggested Readings

Cronquist AJ. 1981. *An Integrated System of Classification of Flowering Plants*. Columbia Univ. Press, New York.

David Briggs. 1997. *Plant Variation and Evolution*. Science Publ.

Dhillon BS, Varaprasad KS, Kalyani Srinivasan, Mahendra Singh, Sunil Arachak, Umesh Srivastava & Sharma GD. 2001. *Germplasm Conservation A Compendium of Achievements*. NBPGR, New Delhi.

di Castri, F & Younes T. 1996. *Biodiversity Science and Development: Towards New Partnership*. CABI, In association with International Union for Biological Science, France.

Gurcharan Singh. 2004. *Plant Systematics: An Integrated Approach*. Science Publ.

John H Wiersema. 1999. *World Economic Plants: A Standard Reference*. Blanca Leon.

Lawrence GMH. (Ed.) 1951. *Taxonomy of Vascular Plants*. London.

Lorentz C Pearson. 1995. *The Diversity and Evolution of Plants*. CRC Press.

Paroda RS & Arora RK. 1991. *Plant Genetic Resources Conservation and Management Concepts and Approaches*. IBPGR Regional office for south and south Asia New Delhi.

Singh BP. 1993. *Principles and Procedures of Exchange of Plant Genetic Resources Conservation and Management*. Indo-US PGR project management.

Sivarajan VV. 1991. *Introduction of Principles of Plant Taxonomy*. Science Publ.

Takhrajan A. 1997. *Diversity and Classification of Flowering Plants*. Columbia University Press, New York.

GP 517 DATABASE MANAGEMENT, EVALUATION AND UTILIZATION OF PGR 2+1 SEM - II

Objective

To train the students in germplasm data base management using modern tools and softwares.

Theory

UNIT-I: Statistical techniques in management of germplasm, core identification, estimation of sample size during plant explorations, impact of sampling on population structure; sequential sampling for viability estimation, introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and nomograms, estimation of sample size for storage and viability testing.

UNIT-II: Germplasm documentation; basics of computer and operating systems, database management system, use of statistical softwares, pictorial and graphical representation of data; introduction to communication network.

UNIT-III: Germplasm management system: global scenario, genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections; necessity of germplasm evaluation; predictive methods for identification of useful germplasm;characterization of germplasm and evaluation procedures including specific traits, Gene markers and their use in PGR management, germplasm enhancement, prebreeding and utilizing wild species in crop improvement.

UNIT-IV: Management and utilization of germplasm collections; concept of core collection, molecular markers and their use in characterization, evaluation and utilization of genetic resources; pre-breeding/ genetic enhancement, utilizing wild species for crop improvement; harmonizing agro-biodiversity and agricultural development crop diversification; participatory plant breeding.

Practical

Basics of computer and operating systems- identification of useful germplasm; evaluation of crop germplasm, Statistical techniques in management of germplasm- estimation of sample size for storage and viability testing. Evaluation procedure and experimental protocols (designs and their analysis), Assessment of genetic diversity; Techniques of Characterization of germplasm, Molecular markers and their use in characterization.

Suggested Readings

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.

Puzone L & Th. Hazekamp 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

GP 518/ PSMA 505 BREEDING OF MEDICINAL AND AROMATIC CROPS 2+1 SEM - II

Objective

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

UNIT-I: Plant bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops; Scope for improvement of Medicinal and Aromatic Crops through selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches.

UNIT-II: Breeding for yield and quality improvement in medicinal plants, Breeding for high herbage yield, essential oil and quality components, secondary metabolites in medicinal and aromatic crops; Genetics of active principles and assay techniques useful in evaluation of breederôs material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

UNIT-III: Achievements and prospects in breeding of medicinal crops, *viz*. *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, Stevia, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, *Dioscorea* sp.

UNIT-IV: Prospects in breeding of medicinal crops, *viz. Chlorophytum* sp, *Rauvolfia serpentina, Aloe vera, Ocimum* sp*, Phyllanthus amarus, Solanum* sp.

UNIT-V: Prospects in breeding of aromatic crops viz., Geranium, vettiver, Lemon grass, Palmarosa, citronella, Rosemary, Patchouli, Eucalyptus, Artemisia and Mint.

Practical

Description of Botanical features, Cataloguing of cultivars, varieties and species in medicinal and aromatic crops, Floral Biology, Selfing and crossing, Evaluation of hybrid progenies, Induction of economic mutants, High alkaloid and high essential oil mutants, evolution of mutants through physical and chemical mutagens, Introduction of polyploidy, Screening of plants for biotic and abiotic stress and environmental pollution, *in-vitro* breeding in medicinal and aromatic crops.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. XI. Malhotra Publ. House.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops.* Natural Remedies Pvt. Ltd.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ.

Kurian A & Asha Sankar, M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.

Prajapati ND, Paero Hit SS, Sharma AK, Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios (India).

Skaria P Babu. 2007. *Aromatic Plants*. New India Publ. Agency.

Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*. CSIR.

GP 601 ADVANCED GENETICS 2+0 SEM - I

Objective

To acquaint the students about the recent advances in the field of general genetics.

Theory

UNIT-I: Gene regulation in prokaryotes- Lac operon; Gal operon; Arabinose operon, Tryp operon; Repressor versus attenuation; Regulation of lytic and lysogenic phages; Gene regulation in eukaryotes; Genetic control of antibody diversity.

UNIT-II: Regulatory units in yeast; Mechanisms of genetic recombination; Illegitimate and site specific recombination, flagellar antigen switching in *Salmonella*; mating type switching in *S. cerevisiae*, Polymorphism; Methods of studying polymorphism at biochemical and DNA level; Genetics of mitochondria and chloroplasts; Discussion on complex loci with reference to gene concept, Discussion on recent topics in the field of genetics.

Suggested Readings

Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.

Selected articles from journals.

GP 602 CELLULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING 2+0 SEM - II

Objective

This course focuses on the advanced techniques in analyzing chromosome structure and manipulations for genome analysis in crop species.

Theory

UNIT-I: Organization and structure of genome ï Genome size ï Organization of organellar genomes ï Nuclear DNA organization ï Nuclear and Cytoplasmic genome interactions and signal transduction, Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content ï C ï value paradox ï sequence complexity ï Introns and Exons ï Repetitive sequences ï Role of repetitive sequence in crop evolution.

UNIT-II: Karyotyping ï Chromosome banding and chromosome painting Tracking introgressions using FISH, GISH, loclalization and mapping of genes/genomic segments. ï Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.

UNIT-III: Applications of cytogenetical methods for crop improvement; location and mapping of genes on chromosomes: deficiency method; interchange-genetic consequence,

identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; multiple interchanges-use in producing inbreds, transfer of genes-linked marker methods; Duplication - production and use; inversions and location of genes; B/A chromosome translocations and gene location.

UNIT-IV: Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non-allelic interactgions, telocentric method of mapping.

UNIT-V: Barriers to interspecific and intergeneric hybridization, Behaviour of interspecific and intergeneric crosses ï Totipotency of cells ï Morphogenesis: in vivo and in vitro ï Meristem culture ï anther and pollen culture ï ovule, ovary, embryo and endosperm culture ï protoplast isolation and culture ï protoplast fusion, Different pathways of *in vitro* morphogenesis ï organogenesis and somatic embryogenesis ï *In vitro* mutant/somaclone selection for biotic and abiotic stresses.

Suggested Readings

Clark MS & Wall WJ. 1996. *Chromosomes: The Complex Code*. Chapman & Hall.

Conger BV. (Ed.). 1981. *Cloning Agricultural Plants via in vitro Techniques*. CRC Press.

Constabel F & Vasil IK. (Eds.). 1988. *Cell Culture and Somatic Cell Genetics of Plants*. Vol. V. *Cell Culture and Phytochemicals in Plant Cell Cultures*. Academic Press.

Lal R & Lal S. (Eds.). 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.

Mantel SH & Smith H. 1983. *Plant Biotechnology*. Cambridge University Press.

Sen SK & Giles KL. (Eds.). 1983. *Plant Cell Culture in Crop Improvement*. Plenum Press.

GP 603 ADVANCED BIOMETRICAL AND QUANTITATIVE GENETICS 2+1 SEM - I

Objective

Knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT-I: Basic principles of Biometrical Genetics - selection of parents - Advanced biometrical models for combining ability analysis -Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes; Designs and Systems - Selection of stable genotypes.

UNIT-II: Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) model and other related models - Principal Component Analysis model.

UNIT-III: Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Biplots and mapping genotypes.

UNIT-IV: Genetic architecture of quantitative traits - conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance - Construction of saturated linkage maps, concept of framework map development, QTL mapping; Strategies for QTL mapping - desired populations , - statistical methods , : 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: heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Practical

Working out efficiency of selection methods in different population and interpretation - Biparental mating ï use of softwares in analysis and result interpretation - Triallel analysisï use of softwares in analysis and result interpretation - Quadriallel analysis ï use of softwares in analysis and result interpretation - Triple Test Cross (TTC) ï use of softwares in analysis and result interpretation - Advanced biometrical models for combining ability analysis - Selection of stable genotypes using stability 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. Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

Suggested Readings

Bos I & P Caligari. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.

Falconer DS. 1983. *Problems on Quantitative Genetics*. Longman.

Falconer DS. 1998. *Introduction to Quantitative Genetics*. Longman.

Mather K & Jinks L. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.

Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 604 GENOMICS IN PLANT BREEDING 2+1 SEM - II

Objective

To impart practical skills in advanced molecular techniques in genome mapping and development of transgenic crops.

Theory

UNIT-I: Introduction to the plant genome- Plant genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.

UNIT-II: Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding ï Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci- Map based cloning of plant genes.

UNIT-III: Functional genomics- Regulation of Plant gene expression ï Expression Analysis using Microarrays ï Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.

UNIT-IV: Genome sequencing in plantsï Principles and Techniques; Applications of sequence information in plant genome analyses - Comparative genomicsï Genome Comparison Techniques: Classical and advanced approaches.

UNIT-V: Detection of Single Nucleotide Polymorphismï TILLING and Eco-TILLING ï Role of transcriptomics, proteomics and metabolomics in linking genome and phenome- Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out studies and high throughput phenotyping.

UNIT-VI: Concept of database development, management and bioinformatics Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical

Chromosome analysis in major field crops - Fluorescence *in situ* hybridization - Comparative genomic hybridization ï Comparative analysis of plant genomes using molecular markers ï Genetic map construction using molecular markers ï Mapping major genes using molecular markers ï QTL mapping in plants ï Comparison across mapping populations ï Understanding the need genetic algorithms in QTL mapping ï Plant Genome Databases ï Computational tools to explore plant genome databases ï Comparative genomics ï Comparison of genome sequences using tools pf bioinformatics- Advanced genomic technologies: TILLING and Eco-TILLING ï DNA Array Technology ï Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.

Suggested Readings

Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.* Wiley Interscience.

Brown TA. 2002. *Genomes*. Wiley-LISS.

Caetano-Anolles G & Gresshoff PM. 1998. *DNA Markers: Protocols, Applications and Overviews*. Wiley-VCH.

Cantor CR & Smith CL (2004). *Genomics*. Wiley.

Galas DJ & McCormack SJ. 2002. *Genomic Technologies: Present and Future*. Calster Academic Press.

Jordan BR. 2001. *DNA Microarrays: Gene Expression Applications*. Springer-Verlag.

Liu BH. 1997. *Statistical Genomics: Linkage, Mapping and QTL Analysis*. CRS Press.

Lynch M & Walsh B. 1998. *Genetics and Analysis of Quantitative Traits*. Sinauer Associates.
Mount DW. 2001. *Bioinformatics. Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
Palzkill T. 2002. *Proteomics*. Kluwer.
Paterson AH. 1996. *Genome Mapping in Plants*. Academic Press.
Pennington SR & Dunn MJ. 2002. *Proteomics: From Protein Sequence to Function*. Viva Books.
Rampal JB. 2001. *DNA Arrays: Methods and Protocols*. Humana Press.

GP 605 PLANT GENETIC RESOURCES AND PRE-BREEDING 2+0 SEM - I

Objective

To provide information about collection, maintenance and use of plant genetic resources for crop improvement.

Theory

UNIT-Il: Historical perspectives and need for PGR conservation, importance of plant genetic resources, taxonomical classification of cultivated plants, Gene pool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; basic genetic resources and transgenes.

UNIT-II: Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm, introduction and exchange; principles of *in vitro* and cryopreservation.

UNIT-III: Germplasm conservation- in situ, ex situ, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; registration of plant genetic resources.

UNIT-IV: PGR data base management, multivariate and clustering analysis, description, national and international protocols for PGR management, PGR for food and agriculture (PGRFA), PGR access and benefit sharing. Role of CGIR system in the germplasm exchange; PBR, Farmers rights and privileges. Seed act, *sui generis* system; geographical indicators, Intellectual property; patents, copyrights, trademarks and trade secrets.

UNIT-V: Journey from wild to domesticate; Genetic enhancement; need for genetic enhancement. Genetic enhancement in pre era and 21st century; Genetic enhancement and plant breeding; reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

UNIT-VI: Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.

UNIT-VII: Post-genomic tools for genetic enhancement of germplasm; prebreeding through chromosome manipulation-Application of biotechnology for Genetic enhancement-Achievements.

UNIT-VIII: Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Prebreeding for crop improvement including hybrid development.

Suggested Readings

Franckel OH & Bennett E. 1970. *Genetic Resources in Plants – their Exploration and Conservation*. Blackwell.
Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. *Plant Germplasm Collecting: Principles and Procedures*. NBPGR, New Delhi.
Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.
Paroda RS & Arora RK. 1991. *Plant Genetic Resources, Conservation and Management. Concepts and Approaches*. IBPFR Regional office for South and South Asia, New Delhi.
Puzone L & Hazekamp TH. 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.
Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.
Singh RJ & Jauhar PP. 2005. *Genetic Resources, Chromosomal Engineering and Crop Improvement*. Vol. I. *Grain Legumes*, Vol. II. *Cereals*. CRC Press, Taylor & Francis Group, USA.

GP 606 ADVANCES IN PLANT BREEDING SYSTEMS 2+0 SEM - II

Objective

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT-I: Facts about plant breeding before the discovery of Mendelism; evolutionary concepts of genetics and plant breeding - Flower development and its importance- genes governing the whorls formation and various models proposed - Mating systems and their exploitation in crop breeding; Types of pollination - Mechanisms promoting cross pollination.

UNIT-II: Self-incompatability and sterility ï Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility - Sterility: male and female sterility ï Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; exploitation in monocots and dicots - Difficulties in exploiting CGMS system in dicots ï case studies and breeding strategies - Nucleocytoplasmic interactions with special reference to male sterility ï Genetic , biochemical and molecular bases.

UNIT-III: Population formation by hybridization - Types of population - Mendelian population, gene pool, composites, synthetics etc. Principles and procedures in the formation of a complex population - Genetic basis of population improvement.

UNIT-IV: Selection in self fertilizing crops: Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); backcross, polycross and test cross.

UNIT-V: Selection in cross fertilizing crops ï Polycross and topcross selections, Mass and recurrent selection methods and their modifications - Mass selection: grided mass selection, ear to row selection, modified ear to row selection, convergent selection, divergent selection - Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) - Recurrent selection for general combining ability (GCA) ï concepts and utilization - Recurrent selection for specific combining ability (SCA) ï usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection) ï Selection in clonally propagated crops ï assumptions and realities.

UNIT-VI: Genetic engineering technologies to create male sterility ; prospects and problems - Use of self- incompatability and sterility in plant breeding ï case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypes into male steriles ï concepts and breeding strategies; case studies - Generating new cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines ï Environmental influence on sterilityï Environmentally Induced Genic Male Sterility (EGMS) - Types of EGMS ; influence on their expression; genetic studies ï Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic Male sterility and its use heterosis breeding - Apomixis and its use in heterosis breeding - Incongruity - Factors influencing incongruity - Methods to overcome incongruity mechanisms.

Suggested Readings

Agarwal RL. 1996. *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford & IBH.

Allard RW. 1966. *Principles of Plant Breeding*. John Wiley & Sons.

Briggs FN & Knowles PF. 1967. *Introduction to Plant Breeding*. Reinhold.

Fehr WR. 1987. *Principles of Cultivar Development: Theory and Technique*. Vol I. Macmillan.

Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.

Mandal AK, Ganguli PK & Banerji SP. 1995. *Advances in Plant Breeding*. Vol. I, II. CBS.

Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

Sharma JR. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.

Simmonds NW. 1979. *Principles of Crop Improvement*. Longman.

Singh BD. 1997. *Plant Breeding: Principles and Methods*. 5th Ed., Kalyani.
Singh P. 1996. *Essentials of Plant Breeding*. Kalyani.
Welsh JR. 1981. *Fundamentals of Plant Genetic and Breeding*. John Wiley.
Williams W. 1964. *Genetical Principles and Plant Breeding*. Blackwell.

GP 607 CROP EVOLUTION 2+0 SEM - II

Objective

To impart knowledge on crop evolutionary aspects and manipulation at ploidy level for crop improvement.

Theory

UNIT-I: Origin and evolution of species; Centres of diversity/origin, diffused centres; Time and place of domestication; Patterns of evolution and domestication-examples and case studies.

UNIT-II: Domestication and uniformity ï Characteristics of early domestication and changes ï Concept of gene pools and crop evolution; Selection and Genetic drift - consequences.

UNIT-III: Speciation and domestication ï The process of speciation ï Reproductive isolation barriers ï Genetic differentiation during speciation ï Hybridization - speciation and extinction.

UNIT-IV: Exploitation of natural variation ï Early attempts to increase variation ï Distant hybridization and introgression- Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer into cultivated species, tools and techniques; Validation of transferred genes and their expression, Controlled introgressions.

UNIT-V: Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; Genome organization ï Transgenesis in crop evolution ï Multifactorial genome ï Intragenomic interaction ï Intergenomic interaction ï Genome introgression.

UNIT-VI: Methods to study crop evolution - Contemporary Methods ï Based on morphological features ï Cytogenetic analysis ï Allozyme variations and crop evolution ï DNA markers, genome analysis and comparative genomics.

UNIT-VII: Evolutionary significance of polyploidy, Evolution of crop plants through ploidy manipulations; polyploids: methods, use of autopolyploids; haploidy-method of production and use; allopolyploids- synthesis of new crops; - Case studies ï Cereals ï Pulses ï Oilseeds ï vegetables, Fibre crops - Plantation crops ï Forage crops ï Tuber crops ï Medicinal Plants.

Suggested Readings

Hancock JF. 2004. Plant Evolution and the Origin of Crop Species. 2nd Ed. CABI.
Ladizinsky G. 1999. *Evolution and Domestication*. Springer.
Miller AJ. 2007. *Crop Plants: Evolution*. John Wiley & Sons.
Smartt J & Simmonds NW. 1995. *Evolution of Crop Plants*. Blackwell.

GP 608 BREEDING DESIGNER CROPS 2+1 SEM - II

Objective

To impart theoretical knowledge and practical know-how towards physiological efficiency, nutritional enhancement, biofortification and industrial/pharma applications in plant breeding.

Theory

UNIT-I: Breeding of crop ideotypes, Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins, vaccines, gums, starch and fats.

UNIT-II: Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode. Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.

UNIT-III: Improvement in yield potential under sub optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

UNIT-IV: Breeding for special traits viz. oil, protein, vitamins, amino acids etc. Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming.

UNIT-V: Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management.

Practical

Demonstration of plant responses to stresses through recent techniques, water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salt shock proteins.

Suggested Readings

Balint A. 1984. *Physiological Genetics of Agricultural Crops*. AK Ademiaikiado.

Hay RK. 2006. *Physiology of Crop Yield*. 2nd Ed. Blackwell.

Pessarakli M. 1995. *Handbook of Plant and Crop Physiology*. Marcel Dekker.

Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates.

GP 609 ADVANCES IN BREEDING OF MAJOR FIELD CROPS 3+0 SEM - I

Objective

To provide insight into recent advances in improvement of cereals, millets and non cereal crops using conventional and modern biotechnological approaches.

Theory

UNIT-I: History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.

UNIT-II: Breeding objectives in ; Rice, Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization. Genetics of quantitative and qualitative traits.

UNIT-III: Breeding for Value addition and resistance to abiotic and biotic stresses.

UNIT-IV: Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT-V: National and International accomplishments in genetic improvement of major field crops and their seed production.

Suggested Readings

Chopra VL. 2001. *Breeding Field Crops - Theory and Practice*. Oxford & IBH.

Davis DD.1978. *Hybrid Cotton Specific Problems and Potentials*. Adv. Agron. 30: 129-157.

Heyne EG. 1987. *Wheat and Wheat Improvement*. 2nd Ed. ASA, CSSA, SSSA Inc Publ.

Khairwal, I.S Rai,K.N, H.Harinaryanan(Eds). 1999. *Pearl Millet Breeding*. Oxford & IBH.

Khairwal I, Ram C & Chhabra AK. 1990. *Pearl Millet Seed Production and Technology*. Manohar Publ.

Nagarajan S, Singh G & Tyagi BS. 1998. *Wheat Research Needs Beyond 2000 AD*. Narosa.

Nanda JS. 2000. *Rice Breeding and Genetics - Research Priorities and Challenges*. Oxford & IBH.

Rao VS, Singh G & Misra SC. 2004. *Wheat: Technologies for Warmer Areas*. Annamaya Publ.

Reynolds MP, Rajaram S, McNab A. 1996. *Increasing Yield Potential in Wheat: Breaking the Barriers*. Proc. Workshop held in Ciudad, Obregon, Sonora, Mexico.

Seth BL, Sikka SM, Dastur RH, Maheshwari P, Rangaswamy NS & Josi AB. 1960. *Cotton in India – A Monograph.* Vol. I. ICAR.

Singh BD. 2006. *Plant Breeding - Principles and Methods*. Kalyani.

Singh P & Singh S. 1998. *Heterosis Breeding in Cotton*. Kalyani.

Singh P. 1998. *Cotton Breeding*. Kalyani.

Singh S & Singh P. 2006. *Trends in Wheat Breeding*. Kalyani.

GP 610/ SST 602 ***IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM** **2+1** **SEM - II**

Objective

To impart knowledge on the methods of germplasm conservation.

Theory

UNIT-I: Concept of natural reserves and natural gene banks, *In situ* conservation of wild species in nature reserves: *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation; *in situ* conservation of agro-biodiversity on-farm; scientific basis of *in situ* conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of *in situ* conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT-II: *Ex situ* conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, *perma-frost* conservation, guidelines for sending seeds to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling ,clonal repositories, genetic stability under long term storage condition.

UNIT-III: *In vitro* storage, maintanence of *in vitro* culture under different conditions, invitro bank maintanence for temporate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems , prospects of *in vitro* gene bank.

UNIT-IV: Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants,dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation I agriculture, horticulture and forestry crops.Problems and prospects, challenging aheads.

Practical

In situ conservation of wild species ï case studies at national and international levels, Ex situ techniques for active and long-term conservation of collections, preparation and handling of materials, packaging, documentation; design of cold storage modules, conservation protocols for recalcitrant and orthodox seeds, cytological studies for assessing genetic stability, *in vitro* cultures- embryo,cell/suspension cultures,pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR - study using fruit crops and other horticultural crops.

Suggested Readings

Ellis RH & Roberts EH & White Head J. 1980. *A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks*. FAO / IBPGR Pl. Genet. Resources News 41-3-18.

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press, Cambridge.

Simmonds, N.W. 1979. *Principles of Crop Improvement* Longman.

Westwood MN. 1986. *Operation Manual for National Clonal Germplasm Repository Processed Report*. USDA-ARS and Orgon State Univ. Oregon, USA.

Withers LA. 1980. *Tissue Culture Storage for Genetic Conservation*. IBPGR Tech. Rep. IBPGR, Rome, Italy.

GP 611 **MICROBIAL GENETICS** **2+1** **SEM - I**

Objective

The objective of this course is to apprise the students of molecular processes at DNA and RNA level in different microorganisms, especially bacteria and viruses with focus on mutation and repair mechanism, genetics of N_2 fixation.

Theory

UNIT-I: Nature of bacterial variation; Molecular aspects of mutation; Episomes and plasmids; Gene mapping in bacteria; Life cycle of bacteriophages; Genetic finestructure analysis of rII locus; Circular genetic map of phage T4; Transposable genetic elements; Biochemical genetics of *Neurospora and Saccharomyces* ; One gene - one enzyme hypothesis.

UNIT-II: Gene isolation , synthesis and cloning; Genomic and cDNA library; PCR based cloning, positional cloning; Nucleic acid hybridization and immuno-chemical detection;

DNA sequencing, DNA restriction and modification , RNA editing; Anti-sense RNA and ribozyme; Synthesis and use of synthetic oligonucleotides.

UNIT-III: Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Molecular chaperones and gene expression; Genetic basis of apoptosis.

UNIT-IV: Transgenic bacteria and bioethics; Gene silencing; Genetic basis of nodulation, nitrogen fixation and competition by *rhizobia;* Genetic regulation of nitrogen fixation and quorum sensing in *rhizobia;* Genetics of mitochondria and chloroplasts.

Practical

Preparation and sterilization of liquid and agar bacterial nutrient media; Assessment of generation time in the log-phage bacterial cultures; Handling of microorganisms for genetic experiments; Isolation of rhizobia from nodules; Gram staining of rhizobial cells; Examination of polyhydroxy butyrate (PHB) production in rhizobia; Demonstration of N2-fixing nodules/bacterial inoculation in the legume-*Rhizobium* symbiotic system; Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria; Determination of spontaneous and induced mutation frequencies; Discrete bacterial colony counts for the preparation of survival curves and determination of LD50 of a mutagen; Tn-mediated mutagenesis; Analysis and isolation of plasmid DNA; Curing of plasmids.

Suggested Readings

Brooker RJ. 2004. *Genetics Analysis and Principles*. Addison-Wesley Longman.

Brown TA. 2002. *Genomes.* Bios Scientific Publ.

Griffiths AJF. 2000. *An Introduction to Genetic Analysis*. WH Freeman.

Hexter W & Yost HT. 1976. *The Science of Genetics*. Prentice Hall.

Karp G. 2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.

Lewin B. 2008. *Genes IX*. John Wiley & Sons.

Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.

Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.

Tamarin RH. 1999. *Principles of Genetics*. Wm C Brown Publ.

Watson JD. 2004. *Molecular Bilology of the Gene*. Pearson Edu.

Yadav AS, Vasudeva M, Kharab P & Vashishat RK. 2002. *Practical Manual on Microbial and Molecular Genetics*. Dept. of Genetics, CCS HAU, Hisar.

GP 612/ PSMA 605 — ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS — 2+1 — SEM - II

Objective

To update knowledge on the recent research trends in the field of breeding of medicinal and aromatic crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT-I: Origin and evolution of varieties, distribution- Genetic resources, genetic divergence, Plant introduction, selection and domestication - Inheritance of important characters, Genetic mechanisms associated with alkaloids and secondary metabolites.

UNIT-II: Methods of breeding suited to seed and vegetative propagated crops. Polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops.

UNIT-III: Specific breeding objectives in medicinal and aromatic crops, Genetic bio diversity, Breeding problems and improvements in Senna, Periwinkle, Aswagandha, Isabgol, Sarpagandha, Poppy, Glory lily, *Coleus, Mucuna and Ocimum,* Centella, Bacopa, Dioscorea, Solanum, Andrographis, *Aloe vera*, Phyllanthus, Eucalyptus, Bael, Cinchona.

UNIT-IV: Specific breeding objectives in medicinal and aromatic crops, Genetic bio diversity, Breeding problems and improvements in Henbane aromatic grasses, Geranium, Patchouli, Artemisia, Rosemary, Thyme, Sage, Marjoram, Fever few.

UNIT-V: Biotechnological approaches for crop improvement of medicinal and aromatic crops.

Practical

Description of crops and cultivars, Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies, Induction of economic, colour mutants, Increased alkaloid content in medicinal crops, high essential oil content in

aromatic plants, Physical and chemical mutagens, Induction of polyploidy, Screening of plants for biotic and abiotic stresses and environmental pollution, *in-vitro* breeding in flower crops, medicinal and aromatic crops.

Suggested Readings

Atal C & Kapoor V. 1992. *Cultivation and Utilization of Medicinal and Aromatic Crops*. CSIR.

Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol.XI. Malhotra Publ. House.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.

Handa SS & Kaul MK. 1982. *Cultivation and Utilization of Medicinal Plants*. NISC, CSIR.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ.

Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.

Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*. CSIR.

GENETICS AND PLANT BREEDING

List of Journals

- Australian Journal of Agricultural Research, Australia
- Australian Journal of Biological Sciences, Australia
- Biometrics, UK
- BioTechniques
- Breeding Science, Japan
- Cereal Research Communication, Hungary
- Cotton Research and Development, Hisar, India
- Critical Reviews in Plant Sciences
- Crop Improvement, Ludhiana
- Crop Science, USA
- Current Science, Bangalore
- Czech Journal of Plant Breeding Genetics, Prague,
- Electronic Journal of Biotechnology
- Euphytica, The Netherlands
- FABIS Newsletter
- Forage Research, Hisar, India
- Genetic resources and crop evolution, Netherlands
- Genetics, USA
- Genome, Canada
- Haryana Agricultural University Journal of Research, Hisar, India
- Heredity
- Hilgardia, Sweden,
- Indian Journal of Agricultural Research, New Delhi
- Indian Journal of Genetics and Plant Breeding, New Delhi
- Indian Journal of Plant Genetic Resources, New Delhi
- International Chickpea Newsletter, ICRISAT
- International Rice Research Notes, IRRI, Philippines
- Journal of Agricultural Research, U.K.
- Journal of Biochemistry and Biotechnology, New Delhi
- Journal of Genetics and Breeding, Italy
- Journal of Heredity
- Journal of Pulses Research, Kanpur
- Legume Research, Karnal
- Madras Agricultural Journal, Coimbatore, India
- MILWAI Newsletter
- Molecular Breeding, USA
- Mutation Research
- National Journal of Plant Sciences, Hisar, India
- Nucleic Acids Research, USA
- Oryza, Cuttack, India
- PGR Newsletter, Syria
- Plant Breeding, Germany
- Plant Molecular Biology, The Netherlands
- Rachis, Syria
- Sorghum and Millet Newsletter, ICRISAT
- Theoretical and Applied Genetics, Germany

e-Resources

Name of the Journal	URL
Agronomy Research	http://www.eau.ee/~agronomy/
Asian Journal of Plant Sciences	http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ajps
Breeding Science	http://www.jstage.jst.go.jp/browse/jsbbs
Current Science	http://www.ias.ac.in/currsci/index.html
International Journal of Botany	http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ijb
International Journal of Sociology of Agriculture and Food	http://www.csafe.org.nz/ijsaf/
Japan Agricultural Research Quarterly	http://ss.jircas.affrc.go.jp/english/publication/jarq/index.html
Japanese Journal of Crop Sc.	http://www.jstage.jst.go.jp/browse/jcs
Journal of Agronomy	http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ja
Journal of Biosciences	http://www.ias.ac.in/jbiosci/index.html
Journal of Cotton Science	http://www.cotton.org/journal/
Journal of Genetics	http://www.ias.ac.in/jgenet/index.html
Plant Biotechnology	http://www.jstage.jst.go.jp/browse/plantbiotechnology
Plant Production Science	http://www.jstage.jst.go.jp/browse/pps
Scientia Agraria	http://calvados.c3sl.ufpr.br/ojs2/index.php/agraria
Tropicultura	http://www.bib.fsagx.ac.be/tropicultura/
Turkish Journal of Agriculture and Forestry Sciences	http://journals.tubitak.gov.tr/agriculture/index.php

Other Major Portals for Genetics and Plant Breeding

- http://www.icrisat.org/
- http://121.244.161.11/Search/QuickSearch.asp
- http://www.plantstress.com/WRFiles/literaturewr.htm (portal for several sites)
- http://www2.unil.ch/lpc/docs/index_plants.htm (portal for several sites)
- http://www.dnaftb.org/dnaftb/ (portal for several sites)

Suggested Broad Areas for Master's and Doctoral Research

- Studies on stay-green traits in relation to genes affecting efficiency of photosynthethesis, biotic/abiotic stress tolerance
- Genetics of AGP system for better photosynthesis and translocation
- Identification of genes/QTLs for NUE and WUE
- Molecular markers tagged to genes/QTLs identified for improvement of nutrient use efficiency, water use efficiency and stress tolerance
- MAS based mobilization of transgenes for tolerance to biotic and abiotic stresses into desirable agronomic backgrounds
- Breeding methologies to enhance selection efficiency
- Component approaches and development of selection criteria for quantitiative trait improvement
- Stability analyses and methods to estimate the G X E components in breeding materials
- Relative efficiency analyses of genetic component estimation for reliable use in developing selection criteria in crop plants
- Distance and divergence statistics for identification of similarity assessment among genetic stocks and parental genetic material
- Dependable marker systems for detection of introgression in wide crosses with minimized linkage drag
- Analysis of Resistance Gene analogues and their use in MAS with enhanced disease resistance
- Analysis of Gene analogues and expression synteny and their use in MAS with enhanced quality and trait expression
- Refinements in embryo rescue and consequent diplodization for production of double haploids

- Breeding through distant hybridization route for New Plant Type for breaking yield barriers
- Genetics of durable, quantitative resistance and adult plant resistance in major crops against known pathogens
- Development of tools and methodologies for identification of genes responsible for resistance against polyphagus insects
- Localization of genes responsible for specific trait expression using disomic chromosome substitution lines
- Induction of novel variation through mutagenesis tools and identify novel genes for different traits
- Development of heterotic pools for maximized heterosis in cross and self pollinated crops where hybrid seed production tools are available
- Genetics and traits responsible for terminal and initial heat tolerance in wheat, maize and mustard
- Genetics of cold tolerance related traits in Brassica maize, rice and pigeonpea
- Widening the QPM base in maize and prebreeding to add value to the genetic stocks of QPM
- Comparison of relative efficiency of different softwares in analysis of quantitative trait loci and linkages
- Characterization of germplasm using key descriptors at morphological and molecular levels
- Identification of descriptors in crops
- Development of recombinant inbred lines and mapping populations
- Floral biology of underutilized and medicinal and aromatic plants

HORTICULTURE

FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
FLA 501*	BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS	2+1	I
FLA 502*	PRODUCTION TECHNOLOGY OF CUT FLOWERS	2+1	I
FLA 503*	PRODUCTION TECHNOLOGY OF LOOSE FLOWERS	2+1	II
FLA 504*	LANDSCAPING AND ORNAMENTAL GARDENING	2+1	I
FLA 505*	PROTECTED FLORICULTURE	2+1	II
FLA 506*	VALUE ADDITION IN FLOWERS	2+1	II
FLA 507	TURFING AND TURF MANAGEMENT	2+1	I
FLA 508 ❶	CAD FOR OUTDOOR AND INDOORSCAPING	2+1	II
FLA 591	MASTERôS SEMINAR	1	I, II
FLA 599	MASTERôS RESEARCH	20	I, II
FLA 601**	ADVANCES IN BREEDING OF FLOWER CROPS	2+1	II
FLA 602**	ADVANCES IN FLOWER PRODUCTION TECHNOLOGY	2+1	I
FLA 603	ADVANCES IN PROTECTED AND PRECISION FLORICULTURE	2+1	I
FLA 604**	ADVANCES IN LANDSCAPE ARCHITECTURE	1+2	II
FLA 605/ ❷ MBB 604/ VSC 604	ADVANCES IN CROP BIOTECHNOLOGY	3+0	I
FLA 691	DOCTORAL SEMINAR I	1	I, II
FLA 692	DOCTORAL SEMINAR II	1	I, II
FLA 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSE			
ABM 534	MANAGEMENT OF FLORICULTURE AND LANDSCAPING	2+0	

*Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

One course of Genetics & Plant Breeding of 3 credits is compulsory as Minor/Supporting

To be taught by: ❶ Floriculture & Landscape Architecture and Computer Section; ❷ Molecular Biology and Biotechnology

FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Structure

FLA 501 BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS 2+1 SEM - I

Objective

To impart comprehensive knowledge about the principles and practices of breeding of flower crops and ornamental plants.

Theory

UNIT-I: Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India.

UNIT-II: Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life.

UNIT-III: Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

UNIT-IV: Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium.

UNIT-V: Breeding constraints and achievements made in ornamental plants ï petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliagesï Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical featuresï Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.

Singh BD. 1990. *Plant Breeding.* Kalyani.

FLA 502 PRODUCTION TECHNOLOGY OF CUT FLOWERS 2+1 SEM - I

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 CO_2 on growth and flowering.

UNIT-III: Flower production ï 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, 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, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages.

Practical

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.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani.

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 503 PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS 2+1 SEM - II

Objective

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

Theory

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 and 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 grading, packing and storage, value addition, concrete and essential oil extraction, trasportation 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

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.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani.

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture.* Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Chadha KL & Chaudhury B.1992. *Ornamental Horticulture in India.* ICAR.
Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.
Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India.* Allied Publ.
Sheela VL. 2007. *Flowers in Trade*. New India Publ. Agency.
Valsalakumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. *Flowering Trees*. New India Publ. Agency.

FLA 504 LANDSCAPING AND ORNAMENTAL GARDENING 2+1 SEM - I

Objective

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

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

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, 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.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.
Woodrow MG.1999. *Gardening in India.* Biotech Books.

FLA 505 PROTECTED FLORICULTURE 2 + 1 SEM - II

Objective

Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.

Theory

UNIT-I: Prospects of protected floriculture in India; Types of protected structures ï Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures ï economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT-II: Environment control ï management and manipulation of temperature, light, humidity, air and CO_2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT-III: Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT-IV: Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT-V: Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, post-harvest handling, packing methods, project preparation, visit to commercial greenhouses.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture.* Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Nelson PV. 1978. *Green House Operation and Management*. Reston Publ. Co.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 506 VALUE ADDITION IN FLOWERS 2+1 SEM - II

Objective

To develop understanding of the scope and ways of value addition in flowers.

Theory

UNIT-I: Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management.

UNIT-II: Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.

UNIT-III: Dry flowersï Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making ï Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement ï dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage.

UNIT-IV: Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

Practical

Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers; Techniques in flower arrangement; Techniques in floral decoration; Identification of plants for dry flower making; Practices in dry flower making; Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.; Visit to dry flower units, concrete and essential oil extraction units.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture.* Vols. I-VI. Pointer Publ.
Chadha KL.1995. *Advances in Horticulture*. Vol.XII. Malhotra Publ. House.
Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007.*Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 507 TURFING AND TURF MANAGEMENT 2+1 SEM - I

Objective

To develop understanding of the principles and management of turfing.

Theory

UNIT-I: Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.

UNIT-II: Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement-Adaptation; Turfing for roof gardens.

UNIT-III: Preparatory operations; Growing media used for turf grasses - Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.

UNIT-IV: Turf management ï Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing -- mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.

UNIT-V: Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

Practical

Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices ï mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic stress management; Project preparation for turf establishment, visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics.

Suggested Readings

Nick-Christians 2004. *Fundamentals of Turfgrass Management*. www.amazon.com

FLA 508 CAD FOR OUTDOOR AND INDOORSCAPING 2+1 SEM - II

(To be taught jointly by Floriculture & Landscape Architecture and Computer Section)

Objective

To impart basic knowledge about the operation of Computer Aided Designing (CAD) in landscape garden designing.

Theory

UNIT-I: Exposure to CAD (Computer Aided Designing) ï Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing.

UNIT-II: 2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects.

UNIT-III: Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout.

UNIT-IV: 3D drawing methods, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD.

UNIT-V: ARCHICAD organization tools, Dimensioning and detailing of designs, Attribute settings of components, Visualization tools for landscape preview, Data

management, plotting and accessories for designing, Inserting picture using photoshop, Making sample drawing for outdoor and indoor gardens.

Practical

Practices in point picking methods, Using tool bars and icons, Using modifying tools and modifying comments, Isometric drawings, Using productivity tools, Drawing designs by AUTOCAD for home garden, institutional garden and special types of garden, Using tools and info-box for 3D drawing, Creation of garden components with ARCHICAD, Organization, dimensioning, detailing and visualization tools with ARCHICAD, Using Photoshop package for 3D picture insertion, Drawing designs with ARCHICAD for home garden, interior garden designing, IT parks, Corporates, Theme parks and Ecotourism spots.

Suggested Readings

Christine Wein-Ping Yu 1987. *Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture*. amazon.com

FLA 601 ADVANCES IN BREEDING OF FLOWER CROPS 2+1 SEM - II

Objective

To update knowledge on the recent research trends in the field of breeding of flower crops with special emphasis on crops grown in India.

Theory

UNIT-I: Origin and evolution of varieties, distribution, Genetic resources, genetic divergence, Plant introduction, selection and domestication, Inheritance of important characters, Genetic mechanisms associated with flower colour and flower size, doubleness, fragrance and post-harvest life, Plant Variety Protection Act.

UNIT-II: Specific objectives of breeding in flower crops, Methods of breeding suited to seed and vegetatively propagated flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility-Incompatibility problems, *In Vtro* breeding.

UNIT-III: Breeding for resistance to pests, diseases, nematodes and other biotic and abiotic stresses in flower crops.

UNIT-IV: Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, gerbera, gladioli, orchids and anthurium.

UNIT-V: Specific breeding problems and achievements made in aster, petunia, liliums, heliconia, bird of paradise, hibiscus and bougainvillea.

Practical

Description of crops and cultivars; Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies; Induction of mutants; Physical and chemical mutagens; Induction of polyploidy; Screening of plants for biotic and abiotic stresses and environmental pollution; *in-vitro* breeding in flower crops.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Choudhary RC.1993. *Introduction to Plant Breeding.* Oxford & IBH.
Singh BD.1990. *Plant Breeding*. Kalyani.

FLA 602 ADVANCES IN FLOWER PRODUCTION TECHNOLOGY 2+1 SEM - I

Objective

To keep abreast with latest developments and trends in production technology of flower crops.

Theory

UNIT-I: Commercial flower production; Scope and importance; Global Scenario in cut flower production and trade, varietal wealth and diversity; Soil and Environment; Special characteristics and requirements; cut flower, loose flowers, dry flowers and floral oil trade.

UNIT-II: Propagation and multiplication; IPR issues related to propagation of materials; Greenhouse management; Soil/media decontamination techniques; Microirrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of

environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and flowering; regulation for quality flowers.

UNIT-III: Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation; Harvest indices; Harvesting techniques; Post-harvest handling; Precooling, pulsing, packing, marketing; Export potential; Agri Export Zones.

UNIT-IV: Crop specific practices ï rose, anthurium, orchids, carnation, gladioli, gerbera, liliums, heliconia, bird of paradise, *Jasminum* sp., marigold, tuberose, crossandra.

UNIT-V: Floral oil industry, floral concrete production, extraction methods, recent advances.

Practical

Varietal wealth in flower crops; Greenhouse management; Soil decontamination techniques; Microirrigation; Nutrition and fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Assessing harvest indices; Post-harvest handling; Tissue analysis; Extraction of floral concrete and oils; case studies; visit to commercial cut flower units.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Choudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

George S & Peter KV. 2008. *Plants in a Garden*. New India Publ. Agency.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni. S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 603 ADVANCES IN PROTECTED AND PRECISION FLORICULTURE 2+1 SEM - I

Objective

Appraisal on the advances in protected and precision farming of flower crops.

Theory

UNIT-I: Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance.

UNIT-II: Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques.

UNIT-III: Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, liliums, cut foliage; Harvest indices ï harvesting, PH handling, marketing, export.

UNIT-IV: Precision floriculture, Principles and concepts, Enabling technologies of precision farming, GPS, GIS, Remote sensing, sensors.

UNIT-V: Variability management in precision farming, mapping, variable rate technology, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Practical

Growing structures, basic considerations in establishment and operation of greenhouses, Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques, Crop regulation, special horticultural practices under protected cultivation, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Reddy S, Janakiram B, Balaji T, Kulkarni S, & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 604 ADVANCES IN LANDSCAPE ARCHITECTURE 1+2 SEM - II

Objective

To update knowledge on the recent trends in the field of landscape architecture and developing practical skills.

Theory

UNIT-I: Commercial landscape gardening- History, Plant identification and ecology, Materials of garden design, Design making by different garden styles and types.

UNIT-II: Expenses to model landscaping units of all category, Creativity and communication skills for landscape architect, Way of designing a commercial landscape project.

UNIT-III: Assessing site and plants adaptability for different locations, Landscape engineering (Topographical) survey and designing concept), special techniques in garden landscaping (Burlaping, waterscaping, hardscaping, lawn making, topiary styles specializing, bioaesthetic planning).

UNIT-IV: Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD).

UNIT-V: Contemporary landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Case study with the successful landscapist, Budget / Project cost estimating, Execution strategies, Assessing a successful design in site.

Practical

Commercial landscaping, Plant identification, Materials of garden design, Design making by different garden styles and types. Way of designing a commercial landscape project, visit to model ornamental nursery. Assessing site and plants adaptability for different locations, Landscape engineering (Topographical survey and designing concept). Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD).

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das, P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

FLA 605/ MBB 604/ VSC 604 ADVANCES IN CROP BIOTECHNOLOGY 3+0 SEM - I

(To be taught by Molecular Biology and Biotechnology)

(Pre-requisite MBB 501)

Objective

To discuss specialized topics on the application of molecular tools in breeding of specific crops.

Theory

UNIT-I: Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available tissue culture, transformation, molecular marker and genomic tools for crop improvement.

UNIT-II: Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc).

UNIT-III: Molecular breeding: constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and phylogenetic analysis; molecular tagging of genes/traits; selected examples on marker assisted selection of qualitative and quantitative traits.

UNIT-IV: Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major horticultural crops.

Suggested Readings

Selected articles from journals.

FLORICULTURE AND LANDSCAPE ARCHITECTURE

List of Journals & Magazines

- Acta Horticulture
- Floriculture Today
- Haryana Journal of Horticulture Science
- Horticulture Reviews
- HortScience
- Indian Horticulture
- Indian Journal of Arid Horticulture
- Indian Journal of Horticulture
- Journal of American Society of Horticultural Sciences
- Journal of Applied Horticulture
- Journal of Horticultural Sciences
- Journal of Horticultural Sciences & Biotechnology
- Journal of Japanese Society for Horticulture Science
- Journal of Korean Society for Horticulture Science
- Journal of Landscape architecture
- Journal of Ornamental Horticulture
- Scientia Horticulture
- South Indian Horticulture

Suggested Broad Topics for Master's and Doctoral Research

- Micro-propagation of major flower crops
- Application of genetic engineering in flower crops
- Use of molecular markers in flower crops
- Flower crops improvement
- Crop selection for biotic and abiotic stresses
- Diagnostic and recommended integrated system in floriculture
- Precision farming in floriculture
- Protected cultivation of flower crops
- Post-harvest management of flower crops
- Nutritional and water requirements of flower crops

FRUIT SCIENCE

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
FSC 501*	TROPICAL AND DRY LAND FRUIT PRODUCTION	2+1	I
FSC 502*	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	2+1	II
FSC 503*	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	2+1	II
FSC 504	CANOPY MANAGEMENT IN FRUIT CROPS	1+1	II
FSC 505	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	2+1	I
FSC 506*	BREEDING OF FRUIT CROPS	2+1	I
FSC 507*	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	2+1	II
FSC 508*	GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS	2+1	I
FSC 509/ * ❶ MBB 515	BIOTECHNOLOGY OF HORTICULTURAL CROPS	2+1	II
FSC 510	ORGANIC HORTICULTURE	1+1	I
FSC 511	PROTECTED FRUIT CULTURE	2+1	I
FSC 512	GAP FOR HORTICULTURAL CROPS	1+0	II
FSC 513/ ❷ AGM 507	WEATHER MODIFICATION AND RISK MANAGEMENT STRATEGIES	2+0	I
FSC 591	MASTERôS SEMINAR	1	I, II
FSC 599	MASTERôS RESEARCH	20	
FSC 601**	ADVANCES IN BREEDING OF FRUIT CROPS	2+1	II
FSC 602**	ADVANCES IN PRODUCTION OF FRUIT CROPS	2+1	I
FSC 603	ADVANCES IN GROWTH REGULATION OF FRUIT CROPS	2+1	II
FSC 604/ ❸ BIF 501/ MBB 555	INTRODUCTION TO BIOINFORMATICS	2+1	I
FSC 605	BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS	2+1	I
FSC 691	DOCTORAL SEMINAR I	1	I, II
FSC 692	DOCTORAL SEMINAR II	1	I, II
FSC 699	DOCTORAL RESEARCH	45	
SERVICE COURSES			
ABM 524	FRUIT PRODUCTION AND POST HARVEST MANAGEMENT	2+0	

*Compulsory for Masterôs programme; ** Compulsory for Doctoral programme
One course of Genetics & Plant Breeding of 3 credits is compulsory as Minor/Supporting

To be taught by: ❶ Molecular Biology and Biotechnology; ❷ Agricultural Meteorology; ❸Bioinformatics, Molecular Biology & Biotechnology and Animal Biotechnology

FRUIT SCIENCE

Course Structure

FSC 501 TROPICAL AND DRY LAND FRUIT PRODUCTION 2+1 SEM - I

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, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, 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 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.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits - Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vols. II- IV. Malhotra Publ. House.

Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.

Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 2+1 SEM - II

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 Zones(AEZ) and industrial support.

Crops

UNIT-I: Apple, pear, quince, grapes

UNIT-II: Plums, peach, apricot, cherries

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

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

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 subtropical and temperate orchards, Project preparation for establishing commercial orchards.

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 503 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 2+1 SEM - II

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT-I: Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT-II: Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources ï conservation *in situ* and *ex situ.*

UNIT-III: Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT-IV: Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT-V: GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm ï maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation ï cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press.

Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol. I. Daya Publ. House.

Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.

FSC 504 CANOPY MANAGEMENT IN FRUIT CROPS 1+1 SEM - II

Objective

To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

UNIT-I: Canopy management - importance and advantages; factors affecting canopy development.

UNIT-II: Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT-III: Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

UNIT-IV: Canopy management through plant growth inhibitors, training and pruning and management practices.

UNIT-V: Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

Practical

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

Suggested Readings

Chadha KL & Shikhamany SD. 1999. *The Grape, Improvement, Production and Post Harvest Management*. Malhotra Publ. House.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.

FSC 505 PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 2+1 SEM - I

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: Seed quality, packing, storage, certification, testing. Asexual propagation ï 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 ï principle and methods.

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

UNIT-IV: Micro-propagation ï 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 ï 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 ï case studies, micropropagation, explant preparation, media preparation, culturing ï *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.

Suggested Readings

Hartmann HT & Kester DE. 1989. *Plant Propagation – Principles and Practices*. Prentice Hall of India.

Bose TK, Mitra SK & Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.

Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 506 BREEDING OF FRUIT CROPS 2+1 SEM - I

Objective

To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops

UNIT-I: Mango, banana and pineapple

UNIT-II: Citrus, grapes, guava and sapota

UNIT-III: Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT-IV: Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts

UNIT-V**:** Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding programme for specific traits.

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 507 POST HARVEST TECHNOLOGY FOR FRUIT CROPS 2+1 SEM - II

Objective

To facilitate deeper understanding on principles and practices of post- harvest management of fruit crops.

Theory

UNIT-I: Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT-II: Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT-III: Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage- ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT-IV: Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT-V: Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

Suggested Readings

Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.

Chadha KL & Pareek OP. (Eds.). 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.

Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.

Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.

Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.

Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

FSC 508 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS 2+1 SEM - I

Objective

To develop understanding of growth and development of horticultural crops which have implications in their management.

Theory

UNIT-I: Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT-II: Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT-III: Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brasssinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

UNIT-IV: Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

UNIT-V: Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

Suggested Readings

Buchanan B, Gruiessam W & Jones R. 2002. *Biochemistry and Molecular Biology of Plants*. John Wiley & Sons.

Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.

Fosket DE. 1994. *Plant Growth and Development: a Molecular Approach*. Academic

Press.
Leoplod AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. Mc Graw-Hill.
Peter KV. 2008. (Ed.) *Basics of Horticulture*. New India Publ. Agency.
Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

FSC 509/ MBB 515 BIOTECHNOLOGY OF HORTICULTURAL CROPS 2+1 SEM - II

(To be taught by Molecular Biology & Biotechnology)

Objective

Understanding the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.

Theory

UNIT-I: Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT-II: Callus culture - types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT-III: Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

UNIT-IV: Physiology of hardening - hardening and field transfer, organ culture ï meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT-V: Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering and transformation in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Practical

An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, protoplast isolation and culture, genetic transformation.

Suggested Readings

Bajaj YPS. (Ed.).1989. *Biotechnology in Agriculture and Forestry*. Vol. V, *Fruits*. Springer.
Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction.* Blackwell Publ.
Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications.* Oxford & IBH.
Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.
Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*.Orient & Longman (Universal Press).
Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency.
Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol.* 11: 118-131
Vasil TK, Vasi M, While DNR & Bery HR.1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.
Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. Academic Press.

FSC 510 ORGANIC HORTICULTURE 1+1 SEM - I

Objective

To develop understanding of organic horticulture production system including GAP.

Theory

UNIT-I: Organic horticulture ï definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT-II: Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT-III: EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT-IV: GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT-V: Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

Practical

Features of organic orchards, working out conversion plan, Input analysis- manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices.

Suggested Readings

Claude A, Vandana S, Sultan I, Vijaya L, Korah M & Bernard D. 2000. *The Organic Farming Reader*. Other Indian Press, Goa.

Gaur AC, Neblakantan S & Dargan KS. 1984 *Organic Manures*. ICAR.

Lampkin N & Ipswich. 1990. *Organic Farming*. Farming Press. London.

Lampkin NH & Padel S. 1992. *The Economics of Organic Farming - An International Perspective.* CABI.

Palaniappan & Annadurai. 2008. *Organic Farming- Theory and Practise*. Scientific Publ.

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. New Delhi.

Rao S. 1977. *Soil Microorganism and Plant Growth*. Oxford & IBH.

FSC 511 PROTECTED FRUIT CULTURE 2+1 SEM - I

Objective

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

Theory

UNIT-I: Greenhouse ï World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effects on plant growth.

UNIT-II: Basics of greenhouse design, different types of structures ï glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

UNIT-III: Interaction of light, temperature, humidity, CO_2, water on crop regulation - Greenhouse heating, cooling, ventilation and shading.

UNIT-IV: Types of ventilation- Forced cooling techniques - Glazing materials - Micro irrigation and Fertigation.

UNIT-V: Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases ï IPM.

Practical

Designs of greenhouse, low cost poly tunnels, nethouse- Regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigation systems, special management practices, project preparation for greenhouses, visit to greenhouses.

Suggested Readings

Aldrich RA & Bartok JW. 1994. *Green House Engineering*. NRAES, Riley, Robb Hall,

Cornell University, Ithaca, New York.
Bhatcharjee BS. 1959. *Rose Growing in Tropics*. Thackarspink & Co.
Laurie A, Kiplingr DD & Nelson KS. 1968. *Commercial Flower Forcing*. McGraw-Hill.
Mears DR, Kim MK & Roberts WJ. 1971. *Structural Analysis at an Experimental Cable-supported Air Inflated Green Houses.* Trans. ASAE.
Pant V Nelson. 1991. *Green House Operation and Management*. Bali Publ.
Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. *Management of Horticultural Crops.* Parts I, II. New India Publ. Agency.

FSC 512 GAP FOR HORTICULTURAL CROPS 1+0 SEM - II

Objective

To impart comprehensive knowledge about the principles and practices of Good Agricultural Practises (GAP) for horticultural crops.

Theory

UNIT-I: Genesis of GAP ï definition/description, components listed by FAO, frame work.
UNIT-II: Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.
UNIT-III: On farm processing, storage, energy and waste management, human health, welfare, safety.
UNIT-IV: Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP etc.

Suggested Readings

Peter KV. 2008. *Basics in Horticulture*. New India Publ. Agency.

FSC 513/ AGM 507 WEATHER MODIFICATION AND RISK MANAGEMENT STRATEGIES 2+0 SEM - I

(To be taught by Agro Meteorology)

Objective

To impart the theoretical and practical knowledge of weather modification techniques with risk management strategies.

Theory

UNIT-I: Historical reviews and theories of weather modification, present status of weather modification for horticulture; atmospheric composition and green house effect.
UNIT-II: Scientific advances in clouds and electrical behavior of clouds; hails suppression, dissipation of fog, modification of frost intensity and severe storms; shelter belts and wind breaks, mulches and anti-transpirants; protection of plants against climatic hazards; air and water pollution; meteorological conditions in artificial and controlled climates - green, plastic, glass and animal houses etc.
UNIT-III: Risk characterization - definitions and classification of risks; characterization of weather and climate related risks in horticulture in the region concerned; water related risks; radiation/heat related risks; air and its movement related risks; biomass related risks; social and economic risk factors related to weather and climate.
UNIT-IV: Approaches, tools and strategies to deal with risks; methods for weather and climate related risk assessments; mitigating practices before occurrence; preparedness for the inevitable risks; contingency planning and responses; disaster risk mainstreaming.
UNIT-V: Perspectives for farm applications - farm applications not yet dealt with, such as making risk information products more client friendly and transfer of risk information products to primary and secondary users of such information; challenges for developing coping strategies including transferring risks through insurance schemes; application of methods that permit the incorporation of seasonal and long-term forecasts into the risk assessment models.

Suggested Readings

Anonymous 2003. *Critical Issues in Weather Modification Research Board of Atmoshperic Science and Climate*. National Research Council, USA.
Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Chritchfield HJ. 1994. *General Climatology*. Prentice Hall.
Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.

Mavi HS & Graeme J Tupper 2004. *Agrometeorology: Principles and Applications of Climate Studies in Agriculture.* The Haworth Press.
Mavi HS. 1994. *Introduction to Agrometeorology*. Oxford & IBH.
Menon PA. 1989. *Our Weather.* National Book Trust.
Pearce RP. 2002. *Meteorology at the Millennium.* Academic Press.
Rosenberg NJ, Blad BL & Verma SB. 1983. *Microclimate – The Biological Environment.* John Wiley & Sons.
Samra JS, Pratap Narain, Rattan RK & Singh SK. 2006. *Drought Management in India*. Bull. Indian Society of Soil Science 24, ISSS, New Delhi.

FSC 601 ADVANCES IN BREEDING OF FRUIT CROPS 2+1 SEM - II

Objective

To update knowledge on the recent research trends in the field of breeding of fruit crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits , recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops.

Crops

UNIT-I: Mango and banana
UNIT-II: Papaya, grapes and citrus
UNIT-III: Guava and sapota
UNIT-IV: Pineapple and avocado
UNIT-V: Apple, pear, plums, peaches, apricot, cherries and strawberry

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops.

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
Gowen S. 1996. *Banana and Plantains*. Chapman & Hall.
Janick J & Moore JN. 1996. *Fruit Breeding.* Vols.I-III. John Wiley & Sons.
Nijjar GS. (Ed.). 1977. *Fruit Breeding in India*. Oxford & IBH.
Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.
Stover RH & Simmonds NW. 1991. *Bananas*. Longman.

FSC 602 ADVANCES IN PRODUCTION OF FRUIT CROPS 2+1 SEM - I

Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to

overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

Crops

UNIT-I : Mango and banana

UNIT-II: Papaya, grapes and citrus

UNIT-III: Guava, sapota and aonla

UNIT-IV: Pineapple, avocado and jack

UNIT-V: Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits – Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical and Subtropical*. Naya Udyog.

Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. *Tropical Horticulture.* Vol. I. Naya Prokash.

Chadha KL & Pareek OP. (Eds.).1996. *Advances in Horticulture*. Vols. II-IV. Malhotra Publishing House.

Chadha KL. 2001. *Handbook of Horticulture*. ICAR.

Nakasone HY & Paull RE. 1998. *Tropical Fruits*. CABI.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 603 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS 2+1 SEM - II

Objective

Appraisal on the advances in growth regulation of fruit crops.

Theory

UNIT-I: Ecophysiological influences on growth and development of fruit crops-flowering, fruit set- Crop load and assimilate partitioning and distribution.

UNIT-II: Root and canopy regulation, study of plant growth regulators in fruit culture-structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.

UNIT-III: Absorption, translocation and degradation of phytohormones ï internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

UNIT-IV: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

UNIT-V: Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation-current topics.

Practical

Root- shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruitset and fruit development stages.

Suggested Readings

Buchanan B, Gruiessam W & Jones R. 2002. *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.

Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.

Fosket DE. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press.

Leoplod AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.

Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

FSC 604/ BIF 501/ MBB 555 ABT 608 **INTRODUCTION TO BIOINFORMATICS** **2+1** **SEM - I**

(To be taught jointly by Bioinformatics, Molecular Biology & Biotechnology and Animal Biotechnology)

Objective

To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.

Theory

UNIT-I: Introduction, biological databases - primary, secondary and structural, Protein and Gene Information Resources - PIR, SWISSPROT, PDB, GenBank, DDBJ. Specialized genomic resources.

UNIT-II: DNA sequence analysis, cDNA libraries and EST, EST analysis, pair wise alignment techniques, database searching, multiple sequence alignment.

UNIT-III: Secondary database searching, building search protocol, computer aided drug design - basic principles, docking, QSAR.

UNIT-IV: Analysis packages - commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

i. Usage of NCBI resources
ii. Retrieval of sequence/structure from databases
iii. Visualization of structures
iv. Docking of ligand receptors
v. BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Edu.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

FSC 605 **BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS** **2+1** **SEM - I**

Objective

To update knowledge on the recent research trends in the field of biotic and abiotic stress management in horticultural crops.

Theory

UNIT-I: Stress ï definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

UNIT-II: Pollution - increased level of CO_2, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT-III: Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

UNIT-IV: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

UNIT-V: Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll flurosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

Suggested Readings

Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC.

Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments.* Wiley Inter. Science.

Gupta US. 1990. *Physiological Aspects of Dry Farming*.

Hsiao TC. 1973. Plant Responses to Water Stress. *Ann. Rev. Plant Physiology* 24: 519-570.

Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

Levitt J. 1972. *Response of Plants to Environmental Stresses*. Academic Press.

Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.

Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.

Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

FRUIT SCIENCE

List of Journals & Magazines

- Acta Horticulture
- Haryana Journal of Horticulture Science
- Horticulture Reviews
- HortScience
- Indian Horticulture
- Indian Journal of Arid Horticulture
- Indian Journal of Horticulture
- Journal of American Society of Horticultural Sciences
- Journal of Applied Horticulture
- Journal of Horticultural Sciences
- Journal of Horticultural Sciences & Biotechnology
- Journal of Japanese Society for Horticulture Science
- Journal of Korean Society for Horticulture Science
- Scientia Horticulture
- South Indian Horticulture

Suggested Broad Topics for Master's and Doctoral Research

- Micro-propagation of fruit crops
- Application of genetic engineering in fruit crops
- Use of molecular markers in fruit crops
- Fruit crop improvement
- Crop selection for biotic and abiotic stresses
- Diagnostic and recommended integrated system in cultivation of fruit crops
- Precision farming in fruit crops
- Protected cultivation of fruit crops
- Root distribution studies in fruit crops
- Canopy management in fruit crops
- Organic fruit cultivation
- Post harvest management of fruit crops
- Value addition in fruit crops
- Rejuvenation of orchards
- Replant problems in perennial fruit crops
- Research on burning problems in horticulture crops like mango malformation, citrus decline, guava wilt, alternate bearing, etc.

NEMATOLOGY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
NEMA 501	PRINCIPLES OF NEMATOLOGY	2+1	I
NEMA 502/ ❶ ENT 503	PRINCIPLES OF TAXONOMY	2+0	I
NEMA 503*	STRUCTURAL AND FUNCTIONAL ORGANIZATION OF NEMATODES	2+1	I
NEMA 504*	CLASSIFICATION OF NEMATODES	2+1	II
NEMA 505*	NEMATOLOGICAL TECHNIQUES	1+2	I
NEMA 506*	NEMATODE DISEASES OF CROPS	3+1	II
NEMA 507	NEMATODE BIOLOGY AND PHYSIOLOGY	2+1	II
NEMA 508	NEMATODE ECOLOGY	2+1	II
NEMA 509	NEMATODE INTERACTIONS WITH OTHER ORGANISMS	1+1	II
NEMA 510*	NEMATODE MANAGEMENT	2+1	II
NEMA 511	BENEFICIAL NEMATODES	1+1	I
NEMA 512/ ❷ ENT 510	PRINCIPLES OF INTEGRATED PEST MANAGEMENT	1+1	I
NEMA 513/ ❸ PL PATH 513	DISEASE RESISTANCE IN PLANTS	2+0	II
NEMA 514/ ❷ ENT 520/ PL PATH 520	PLANT QUARANTINE	2+0	II
NEMA 591	MASTERôS SEMINAR	1	I, II
NEMA 599	MASTERôS RESEARCH	20	I, II
NEMA 601	ADVANCES IN STRUCTURE AND SYSTEMATICS OF NEMATODES	2+1	I
NEMA 602**	CURRENT TOPICS IN NEMATODE DISEASE DEVELOPMENT	3+0	I
NEMA 603**	ADVANCES IN NEMATODE MANAGEMENT	2+1	II
NEMA 604#	PHYSIOLOGICAL AND MOLECULAR NEMATOLOGY	2+1	II
NEMA 605/ ❹ PL PATH 606/ ENTO 613	PLANT BIOSECURITY AND BIOSAFETY	2+0	I
NEMA 691	DOCTORAL SEMINAR I	1	I, II
NEMA 692	DOCTORAL SEMINAR II	1	I, II
NEMA 699	DOCTORAL RESEARCH	45	I, II

* Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

One course of Biochemistry or G&PB of 3 credits is compulsory as Minor/Supporting

To be taught by: ❶ Nematology; ❷ Entmology; ❸ Plant Pathology; ❹Entomology and Plant Pathology

NEMATOLOGY

Course Contents

NEMA 501 PRINCIPLES OF NEMATOLOGY 2+1 SEM - I

Objective

To project the importance of nematodes in agriculture and impart basic knowledge on all aspects of plant nematology.

Theory

UNIT-I: History and growth of Nematology; nematode habitats and diversity- plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry.

UNIT-II: Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology.

UNIT-III: Types of parasitism; nature of damage and general symptomatology; interaction of plant parasitic nematodes with other organisms.

UNIT-IV: Plant nematode relationships, cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes.

UNIT-V: Principles and practices of nematode management; integrated nematode management.

Practical

Studies on kinds of nematodes- free-living, animal, insect and plant parasites; nematode extraction from soil; extraction of migratory endoparasites, staining for sedentary endoparasites; examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

Suggested Readings

Dropkin VH. 1980. *An Introduction to Plant Nematology*. John Wiley & Sons.
Perry RN & Moens M. 2006. *Plant Nematology*. CABI.
Singh RS & Sitaramaiah K. 1994. *Plant Pathogens – Nematodes*. Oxford & IBH.
Thorne G. 1961. *Principles of Nematology*. McGraw Hill, New Delhi.
Walia RK & Bajaj HK. 2003. *Text Book on Introductory Plant Nematology*. ICAR.

NEM 502/ ENT 503 PRINCIPLES OF TAXONOMY 2+0 SEM - I

Objective

To sensitize the students on the theory and practice of classifying organisms and the rules governing the same.

Theory

UNIT-I: Introduction to history and principles of systematics and importance. Levels and functions of systematics. Identification, purpose, methods- character matrix, taxonomic keys. Descriptions- subjects of descriptions, characters, nature of characters, analogy vs homology, parallel vs convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

UNIT-II: Classification of animals: Schools of classification- Phenetics, Cladistics and Evolutionary classification. Components of Biological Classification: Hierarchy, Rank, Category and Taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories. Introduction to numerical, biological and cytogenetical taxonomy.

UNIT-III: 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.

Suggested Readings

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book.* John Wiley & Sons.
Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH
Mayr E. 1971. *Principles of Systematic Zoology*. Tata McGraw-Hill
Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie.

NEMA 503 STRUCTURAL AND FUNCTIONAL ORGANIZATION OF NEMATODES 2+1 SEM - I

Objective

Familiarization with structural organization of nematode body so as to enable the students to understand biology, physiology and classification of nematodes.

Theory

UNIT-I: Introduction and general organization of nematode body.

UNIT-II: Morphology and anatomy of nematode cuticle, hypodermis, musculature and pseudocoelom.

UNIT-III: Digestive system- structural variations of stoma, oesophagus, intestine and rectum in nematodes.

UNIT-IV: Reproductive system- terminology and variations in female and male reproductive systems, nemic eggs and sperms, types of reproduction, spermatogenesis and oogenesis.

UNIT-V: Types and structure of excretory-secretory systems; nervous system and associated sense organs.

Practical

Studies on variations in nematode shapes and sizes, morphological details of cuticle, cuticular markings and ornamentation, variations in stoma, oesophagus, rectum; types and parts of female and male reproductive systems, sense organs, and excretory system.

Suggested Readings

Bird AF & Bird J. 1991. *The Structure of Nematodes*. Academic Press.

Chitwood BG & Chitwood MB. 1950. *An Introduction to Nematology.* Univ. Park Press, Baltimore.

Maggenti AR. 1981. *General Nematology.* Springer-Verlag.

Malakhov VV. 1994. *Nematodes: Structure, Development, Classification and Phylogeny*. Smithsonian Institution Press, Washington DC.

NEMA 504 CLASSIFICATION OF NEMATODES 2+1 SEM - II

Objective

Development of skills in the identification of plant parasitic nematodes up to genera and species levels.

Theory

UNIT-I: Principles of nematode systematics.

UNIT-II: Placement of nematodes in Animal Kingdom and comparison with related organisms.

UNIT-III: Classification of Phylum Nematoda- Orders of Class Adenophorea and Secernentea; Diagnosis of Order Tylenchida- Suborder Tylenchina, Hoplolaimina and Criconematina; Infraorders Tylenchata and Anguinata- their families and genera.

UNIT-IV: Diagnosis of genera and families of Suborders Hoplolaimina and Criconematina.

UNIT-V: Orders Aphelenchida, Dorylaimida, Triplonchida, Rhabditida with emphasis on economically important taxa.

Practical

Identification of common plant parasitic nematodes belonging to Orders Tylenchida, Dorylaimida, Aphelenchida and Triplonchida up to generic level; and up to species level for major nematode pests (root-knot, cyst nematodes etc.) of crops. Identification of EPNs belonging to Order Rhabditida.

Suggested Readings

DeCramer W. 1995. *The Family Trichodoridae: Stubby Root and Virus Vector Nematodes*. Kluwer

Geraert E. 2006. *Tylenchida*. Brill.

Hunt DJ. 1993. *Aphelenchida, Longidoridae and Trichodoridae – their Systematics and Bionomics*. CABI

Siddiqi MR. 2000. *Tylenchida: Parasites of Plants and Insects*. 2nd Ed. CABI.

NEMA 505 NEMATOLOGICAL TECHNIQUES 1+2 SEM - I

Objective

Understanding the principles, theoretical aspects and developing skills in nematological techniques.

Theory

UNIT-I: Principles and use of light, scanning and transmission electron microscopes, and other laboratory equipments.

UNIT-II: Survey and surveillance methods; collection of soil and plant samples; techniques for extraction of nematodes from soil and plant material; estimation of population densities.

UNIT-III: Killing, fixing, clearing and mounting nematodes; measurements, preparation of perineal patterns, vulval cones of cyst nematodes, en-face views and body section of nematodes.

UNIT-IV: *In vitro* and *in vivo* culturing techniques of plant parasitic, bacteriophagous, mycophagus and omnivorous nematodes.

UNIT-V: Staining nematodes in plant tissues; microtomy for histopathological studies; collection of plant root exudates and their bioassay; preparation of plant materials for exhibition.

UNIT-VI: Application of molecular techniques in Nematology.

Practical

Collection of soil and plant samples; extraction of nematodes from soil by Baermann funnel, sieving and decanting, elutriation and sugar centrifugal methods; extraction of cysts from soil; extraction of nematodes from plant material; estimation of population densities; staining plant material for nematodes; killing and fixing nematodes, clearing nematodes by slow and Seinhorstôs methods; preparation of temporary and permanent mounts; measurements, drawing, microphotography, special preparation of nematodes - perineal patterns, vulval cones, en-face and body sections; collection of root exudates, preparation of exhibits of nematode diseased plant material, *in vitro* culturing techniques of nematodes- callous culture, excised root and carrot disc techniques.

Suggested Readings

Ayoub SM. 1981. *Plant Nematology – An Agricultural Training Aid*. NemaAid Publ.

Barker KR, Carter CC & Sasser JN 1985. *An Advanced Treatise on* Meloidogyne. Vol. II. *Methodology*. International *Meloidogyne* Project, NCSU, Raliegh.

Southey JF. 1986. *Laboratory Methods for Work with Plant and Soil Nematodes*. HMSO, London.

Zuckerman BM, Mai WF & Harrison MB. 1985. *Plant Nematology Laboratory Manual*. Univ. of Massachusetts.

NEMA 506 NEMATODE DISEASES OF CROPS 3+1 SEM - II

Objective

To impart basic knowledge about the causal organism, nature of damage, symptoms and control of nematode diseases of agricultural and horticultural crops.

Theory

Diagnosis of causal organism, distribution, host range, biology and life cycle, nature of damage, symptoms, interaction with other organisms, and management of nematode diseases in different crops.

UNIT-I: Cereal crops- Ear-cockle and *tundu* diseases of wheat, *molya* disease of wheat and barley; rice root nematode, rice root-knot and cyst nematode problems, *ufra* and white tip diseases of rice; lesion nematodes, cyst nematodes of maize and sorghum. Other nematodes of minor importance.

UNIT-II: Pulses, Sugarcane, Fibre, Fodder and Oilseed crops- Pigeon pea cyst nematode, root knot nematode, reniform nematode, lesion, lance nematode, sugarbeet cyst and soybean cyst nematode problems. Other nematodes of minor importance.

UNIT-III: Vegetable crops- root-knot disease, reniform nematode, potato cyst nematode; stem and bulb nematode. Nematode problems of protected cultivation. Other nematodes of minor importance.

UNIT-IV: Fruit crops- root-knot disease, reniform nematode, slow decline of citrus, spreading decline of citrus. Mushroom- nematode problems. Other nematodes of minor importance.

UNIT-V: Plantation, medicinal and aromatic crops- burrowing nematode problem of banana, spices and condiments, root-knot and lesion nematode problems of coffee and tea, red ring disease of coconut. Forests- Pine wilt disease. Other nematodes of minor importance.

Practical

Diagnosis of causal organisms; identification of different life cycle stages; study of symptoms and histopathology of nematode damage in different crops, study tours for field diagnosis of nematode problems.

Suggested Readings

Bhatti DS & Walia RK. 1992. *Nematode Pests of Crops*. CBS

Evans AAF, Trudgill DL & Webster JM. 1994. *Plant Parasitic Nematodes in Temperate Agriculture*. CABI.

Luc M, Sikora RA & Bridge J. 2005. *Plant Parasitic Nematodes in Subtropical and Tropical Agriculture*. CABI.

Nickle WR. 1991. *Manual of Agricultural Nematology*. Marcel Dekker.

Perry RN & Moens M. 2006. *Plant Nematology*. CABI.

NEMA 507 NEMATODE BIOLOGY AND PHYSIOLOGY 2+1 SEM - II

Objective

To develop understanding of life cycle patterns, feeding and metabolic processes in phytonematodes which have implications in their management.

Theory

UNIT-I: Host finding and invasion, feeding, hatching, moulting; life cycle patterns in different types of nematodes.

UNIT-II: Types of reproduction, gametogenesis, embryogenesis and post embryogenesis.

UNIT-III: Chemical composition of nematodes, hydrolytic enzymes, pseudocoelome and function of transport.

UNIT-IV: Physiology of digestive system, intermediary metabolism.

UNIT-V: Osmoregulation, physiology of excretory-secretory and neuromuscular systems.

Practical

Studies on embryogenesis and post-embryogenesis, hatching, moulting, life cycle development, feeding, enzymatic assay by electrophoresis.

Suggested Readings

Croll NA. 1970. *The Behaviour of Nematodes: The Activity, Senses and Responses.* Edward Arnold.

Croll NA & Mathews BE. 1977. *Biology of Nematodes.* Blackie.

Lee DL. 2002. *The Biology of Nematodes.* Taylor & Francis.

Lee DL & Atkinson H J. 1976. *Physiology of Nematodes*. MacMillan.

Perry RN & Wright DJ. 1998. *The Physiology and Biochemistry of Free-living and Plant Parasitic Nematodes*. CABI.

Wallace HR. 1963. *The Biology of Plant Parasitic Nematodes*. Edward Arnold.

NEMA 508 NEMATODE ECOLOGY 2+1 SEM - II

Objective

To understand the life of plant parasitic nematodes in their environment; their survival strategies, and how to exploit these for their control.

Theory

UNIT-I: Definition and scope; components of environment; evolution of nematodes; ecological classification, prevalence, distribution and dispersal of nematodes.

UNIT-II: Role of nematodes in the food web; habitat and niche characteristics; community analysis and population estimation models.

UNIT-III: Effects of abiotic and biotic factors on nematodes.

UNIT-IV: Environmental extremes and nematode behaviour- aggregation, swarming, orientation, feeding and reproduction.

UNIT-IV: Survival strategies of nematodes in adverse environment and absence of host.

UNIT-V: Modeling population dynamics and relations with crop performance; ecological considerations in nematode management, data interpretation and systems simulation.

Practical

Study of nematode fauna in varied agro-ecological systems, community analysis of nematode populations, laboratory exercises on influence of abiotic factors on movement and hatching, green-house experiments on effect of abiotic factors on nematode populations and plant growth.

Suggested Readings

Croll NA. 1970. *The Behaviour of Nematodes*: *The Activity, Senses and Responses.* Edward Arnold.

Croll NA & Mathews BE. 1977. *Biology of Nematodes.* Blackie.

Lee DL. 2002. *The Biology of Nematodes.* Taylor & Francis.

Norton DC. 1978. *Ecology of Plant Parasitic Nematodes*. John Wiley.

Poinar G. 1983. *Natural History of Nematodes.* Prentice Hall.

Wallace HR. 1973. *Nematode Ecology and Plant Disease.* Edward Arnold.

NEMA 509 NEMATODE INTERACTIONS WITH OTHER ORGANISMS 1+1 SEM - II

Objective

To understand the role of nematodes in disease complexes involving fungal, bacterial, viral and other organisms.

Theory

UNIT-I: Concept of interaction and its importance in disease complexes and their management involving nematode and other organisms.

UNIT-II: Interaction of plant parasitic nematodes with wilt causing fungal pathogens.

UNIT-III: Interaction of plant parasitic nematodes with root rot and other fungal pathogens.

UNIT-IV: Interaction of plant parasitic nematodes with bacterial pathogens, other nematode species and arthropods.

UNIT-V: Virus transmission by nematodes.

Practical

Green-house experiments to study the role of plant parasitic nematodes in wilt/rot causing fungal and bacterial pathogens.

Suggested Readings

Khan MW. 1993. *Nemic Interactions*. Chapman & Hall.

Lamberti F, Taylor CE & Seinhorst JW. 1975. *Nematode Vectors of Plant Viruses.* Plenum Press.

Sasser JN & Jenkins WR. 1960. *Nematology*: *Fundamentals and Recent Advances with Emphasis on Plant Parasitic and Soil Forms*. Eurasia Publ. House.

NEMA 510 NEMATODE MANAGEMENT 2+1 SEM - II

Objective

To impart comprehensive knowledge about the principles and practices of nematode management.

Theory

UNIT-I: Concepts and history of nematode management; crop loss estimation, ecological and socio-economic aspects, cost-benefit ratios and pest risk analysis.

UNIT-II: Chemical methods- nematicides, their types, classification, mode of action, applicators and application methods, antidotes, and economizing nematicidal use.

UNIT-III: Cultural practices- crop rotations and cropping sequences, fallowing, flooding, soil solarisation, time of sowing, organic amendments of soil, bio-fumigation, antagonistic and trap crops, sanitation etc.

Physical and mechanical methods- use of heat, hot water treatment and other methods of disinfestations of planting material.

UNIT-IV: Biological methods- concepts and terminology, use of predators and parasites as biological control agents, their mass multiplication and field use; phytotherapeutic methods ï use of antagonistic plants and antinemic plant products.

UNIT-V: Genetic methods- plant resistance; legal methods- quarantine regulations; integrated nematode management- concepts and applications.

Practical

In vitro screening of synthetic chemicals and plant products for nematicidal activity, and their application methods; methods for screening of crop germplasm for resistance against nematodes, laboratory exercises on biocontrol potential of fungal, bacterial parasites, and predacious fungi and nematodes.

Suggested Readings

Bhatti DS & Walia RK. 1994. *Nematode Pest Management in Crops*. CBS.

Brown GL. 1977. *The Nematode Destroying Fungi*. CBP.

Brown RH & Kerry BR. 1987. *Principles and Practice of Nematode Control in Crops*. Academic Press.

Chen ZX, Chen SY& Dickson DW. 2004. *Nematology: Advances and Perpectives. Vol. II: Nematode Management and Utilization.* CABI.

Perry RN & Moens M. 2006. *Plant Nematology*. CABI.

Starr JL, Cook R & Bridge J. 2002. *Plant Resistance to Parasitic Nematodes.* CABI.

Whitehead AG. 1997. *Plant Nematode Control*. CABI.

NEMA 511 BENEFICIAL NEMATODES 1+1 SEM - I

Objective

To sensitize about the use of nematodes for the biological control of insect pests of crops, and application of some nematodes as biological models and as indicators of environmental pollution.

Theory

UNIT-I: Beneficial nematode fauna- predators, parasites of insects, molluscs and other pests; Entomophilic nematodes- important groups, types of nematode-insect associations; taxonomic characteristics of nematode parasites of insects.

UNIT-II: Host-parasite relations and life cycle of mermithids, entaphelenchids, thelastomids, sphaerularids and tylenchids.

UNIT-III: Entomopathogenic nematodes- *Steinernema* and *Heterorhabditis,* their morphological characteristics, taxonomic status, biology and mode of action.

UNIT-IV: Entomopathogenic nematodes- mass multiplication techniques, formulations, field applications and efficacy, success stories.

UNIT-V: Nematodes as biological models, nematodes as indicators of pollution, role of nematodes in organic matter recycling.

Practical

Isolation, identification, mass rearing and application methods of entomopathogenic nematodes.

Suggested Readings

Gaugler R & Kaya HK. 1990. *Entomopathogenic Nematodes in Biological Control*. CRC Press.

Gaugler R. 2002. *Entomophilic Nematology*. CABI.

Grewal PS, Ehlars RU & Shapiro DI. 2005. *Nematodes as Biocontrol Agents*. CABI.

Jairajpuri MS & Khan MS. 1982. *Predatory Nematodes (Mononchida)*. Associated Publ.

Nguyen, K. B. & Hunt, D. J. 2007. *Entomopathogenic Nematodes: Systematics, Phylogeny and Bacterial Symbionts.* Nematology Monographs and Prespectives. Vol. V. Brill Leiden.

Wood WB. 1998. *The Nematode* Caenorhabditis elegans. Cold Spring Harbor Press.

Woodring JL & Kaya HK. 1988. *Steinernematid and Heterorhabditid Nematodes: A Handbook of Techniques*. Southern Coop. Bull., Ark. Ag. Ext. Sta.

Zuckerman BM. (Ed.). 1980. *Nematodes as Biological Models*. Vols. I, II. Academic Press.

www2.oardc.ohio-state.edu/nematodes

NEMA 512/ ENT 510 PRINCIPLES OF INTEGRATED PEST MANAGEMENT 1+1 SEM -I

(To be taught by Entomology)

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, biological, 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.

UNIT-IV: Components, classification, bases and mechanisms of host plant resistance; screening techniques, breeding methods including transgenics and importance of plant resistance in IPM.

Practical

Characterization of agro-ecosystems; demonstration of plant resistance in important crops; 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.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ.

Dhaliwal GS, Ram Singh & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* 1st Ed., Springer.

Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer.

Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons.

Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker.

NEMA 513/ PL PATH 513 **DISEASE RESISTANCE IN PLANTS** **2+0** **SEM - II**

(To be taught by Plant Pathology)

Objective

To acquaint with disease resistance mechanisms in plants.

Theory

UNIT-I: Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.

UNIT-II: Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT-III: Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

UNIT-IV: Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

Suggested Readings

Dallice M *et al*.1996. *Molecular Aspects of Pathogenicity and Resistance: Requirement for Signal Transduction.* APS, St Paul, Minnesota.

Deverall BJ. 1977. *Defence Mechanisms in Plants*. Cambridge Univ. Press, Cambridge.

Parker J. 2008. *Molecular Aspects of Plant Diseases Resistance*. Blackwell Publ.

Robinson RA. 1976. *Plant Pathosystems*. Springer Verlag.

Singh BD. 2005. *Plant Breeding – Principles and Methods*. 7th Ed. Kalyani Publ.

Van der Plank JE. 1975. *Principles of Plant Infection*. Academic Press.

Van der Plank JE. 1978. *Genetic and Molecular Basis of Plant Pathogenesis*. Springer Verlag.

Van der Plank JE. 1982. *Host Pathogen Interactions in Plant Disease*. Academic Press.

Van der Plank JE. 1984. *Disease Resistance in Plants*. Academic Press.

NEM 514/ ENT 520/ PL. PATH. 520 **PLANT QUARANTINE** **2+0** **SEM - II**

(To be taught by Entomology)

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT-I: Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine ï domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT-II: Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT-III: Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT-IV: WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Suggested Readings

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM.* Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

NEMA 601 **ADVANCES IN STRUCTURE AND SYSTEMATICS OF NEMATODES** **2+1** **SEM - I**

Objective

Studies on the ultrastructure of plant parasitic nematodes based on TEM and SEM, and appraisal of recent developments in their classification.

Theory

UNIT-I: Ultrastructure of nematode body wall- cuticle, hypodermis and muscles; nematode feeding apparatus, and other parts of alimentary canal.

UNIT-II: Ultrastructure of nematode sense organs, reproductive and excretory-secretory systems.

UNIT-III: Principles and rules of nomenclature and classification; preparation of illustrations, keys and compendia for nematode species and other taxa.

UNIT-IV: Non-conventional approaches of nematode identification- molecular, biochemical, immunodiagnostic, molecular characterization and DNA finger-printing techniques.

UNIT-V: Development of computer-based nematode identification programmes.

Practical

Detailed studies of morphological structures and identification of plant parasitic nematodes up to species level. Drawing and measurements of nematodes, preparation of compendia and keys. Identification of species/races of root-knot and cyst nematodes using PAGE.

Suggested Readings

Barrington EJW. 1967. *Invertebrate Structure and Function*. Nelson, Nairobi.

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book.* John Wiley & Sons.

Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives. Vol. I. Nematode Morphology, Physiology and Ecology*. CABI.

Geraert E. 2006. *Nematology Monographs and Perspectives*. Vol. IV. Brill.

International Commission of Zoological Nomenclature 1999. *International Code of Zoological Nomenclature* 4th Ed. The Natural History Museum.

Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH.

Mayr E. 1969. *Principles of Systematic Zoology.* Tata McGraw-Hill.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie.

NEMA 602 CURRENT TOPICS IN NEMATODE DISEASE DEVELOPMENT 3+0 SEM - I

Objective

To update knowledge on the recent research trends in the field of plant nematode relationships at genetic and molecular level.

Theory

UNIT-I: Mechanisms of pathogenesis, cytological and biochemical changes induced by nematode feeding.

UNIT-II: Plant defense systems, role of phytoalexins etc. against major plant parasitic nematodes.

UNIT-III: Genetic basis of plant resistance to nematodes and identification of resistance genes against economically important nematodes.

UNIT-IV: Application of biotechnological methods in the development of nematode resistant crop cultivars; resistance markers; incorporation of resistance by conventional breeding and transgenic approaches.

UNIT-V: Influence of microorganisms on plant nematode interactions.

Suggested Readings

Barker KR, Pederson GA & Windham GL. 1998. *Plant and Nematode Interactions*. CABI.

Fenoll C, Grundler FMW & Ohl SA. 1997. *Cellular and Molecular aspects of Plant-Nematode Relationships*. Kluwer Academic Press, Dordrecht.

Lamberti F, Giorgi C & Bird D. 1994. *Advances in Molecular Plant Nematology*. Plenum Press.

NEMA 603 ADVANCES IN NEMATODE MANAGEMENT 2+1 SEM - II

Objective

To keep abreast with latest developments and trends in nematode management.

Theory

UNIT-I: Isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents- predacious and parasitic fungi; nematoxic fungal culture filtrates.

UNIT-II: Isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents- parasitic and nematode antagonistic bacteria; predacious mites and predacious nematodes.

UNIT-III: Mass culturing, formulation, quality control, bio-safety and registration protocols of bio-control agents.

UNIT-IV: Phytoalexins, allelochemicals, phytotherapeutic substances, novel nematicides, deployment of resistant varieties and non-host crops in nematode suppressive cropping systems, emergence of resistance breaking biotypes, recent regulatory provisions and methods, quarantine and disinfection.

UNIT-V: Nematode management modules for integrated pest and disease management in cropping systems. Nematode management options and approaches for organic farming and precision farming. Application of GIS and GPS technology for surveillance and management.

Practical

Green-house experiments on the efficacy of fungal and bacterial bio-control agents, botanicals.

Suggested Readings

Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives Vol. II. Nematode Management and Utilization.* CABI.

Jana BL. 2008. *Precision Farming*. Reseachco Books & Periodicals.

Lillesend TW, Kiefer RW & Chipman JW. 1979. *Remote Sensing and Image Interpretation*. John Wiley & Sons.

Poinar GO Jr & Jansson H-B. 1988. *Diseases of Nematodes*. Vols. I, II. CRC Press.

Starr JR, Cook R & Bridge J. 2002. *Plant Resistance to Parasitic Nematodes*. CABI.

Tarafdar JC, Priputhi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ.

Upadhyaya RK, Walia RK & Dubey OP. 2004. *IPM Systems in Agriculture. Vol. IX. Phytonematology*. Aditya Books.

NEMA 604 PHYSIOLOGICAL AND MOLECULAR NEMATOLOGY 2+1 SEM - II

Objective

Appraisal on the application of modern biotechnological tools in Nematology.

Theory

UNIT-I: Cell biology- Structural and functional aspects; genetics and evolution in plant parasitism in nematodes.

UNIT-II: *Caenorhabditis elegans*- a model system for gerontology, cytogenetics, physiology, nutritional, toxicological and pharmacological studies; *Heterodera glycines* as a model for biology, proteomic and genomic studies.

UNIT-III: Chemoreception, neurobiology, and biochemical basis of communication in nematodes, molecular basis of host recognition.

UNIT-IV: Biochemical, genetical and molecular basis of plant nematode interaction; histopathological, cellular and molecular changes in host feeding cells, resistance genes and RNAi technology.

UNIT-V: Biochemical and molecular basis of survival strategies in nematodes, molecular mechanism of host resistance against plant parasitic nematodes, molecular and novel approaches for nematode management.

Practical

Isolation and quantification of proteins from nematode juveniles and eggs; molecular weight determination of nematode protein; ϐ-esterase polymorphism in root-knot nematode; nematode DNA isolation from juveniles and eggs; RFLP of nematode DNA; nematode DNA amplification using PCR for nematode identification, RNAi technology.

Suggested Readings

Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives. Vol. I. Nematode Morphology, Physiology and Ecology*. CABI.

Fenoll C, Grundler FMW & Ohl SA. 1997. *Cellular and Molecular aspects of Plant-Nematode Relationships*. Kluwer Academic Publ.

Gommers EJ & Maas PW. 1992. *Nematology from Molecule to Ecosystem*. European Soc. of Nematologists.

Lamberti F, Giorgi C. & Bird D. 1994. *Advances in Molecular Plant Nematology*. Plenum Press.

Perry RN & Wright DJ. 1998. *The Physiology and Biochemistry of Free-living and Plant Parasitic Nematodes*. CABI.

Riddle DL. 1997. *C. elegans II*. Cold Spring Harbor Press.

Wood WB. 1988. *The Nematode* Caenorhabditis elegans. Cold Spring Harbor Press.

Zuckerman BM. 1980. *Nematodes as Biological Models*. Vols. I, II. Academic Press.

NEMA 605/ PL PATH 606/ ENTO 613 PLANT BIOSECURITY AND BIOSAFETY 2+0 SEM - I

(To be taught jointly by Entomology and Plant Pathology)

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT-I: History of biosecurity, concept of biosecurity, components of biosecurity, Quarantine, Invasive Alien Species, biowarfare, emerging/resurgence of pests and diseases.

UNIT-II: National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT-III: Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008.
www.fao.org/docrep/010/a1140e/a1140e00.htm

Laboratory Biosecurity Guidance.
http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006.pdf
Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan.*
http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_plan.pdf
Biosecurity Australia. www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia
Biosecurity New Zealand. www.biosecurity.govt.nz
DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm
Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns.* NBPGR, New Delhi.
Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-63.
Biosecurity for Agriculture and Food Production.http://www.fao.org/biosecurity/
CFIA. http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtml

NEMATOLOGY

List of Journals

- Annals of Applied Nematology - Society of Nematologists, USA
- Current Nematology - Bioved Research Society, Allahabad, India
- Egyptian Journal of Agronematology ï Egyptian Society of Agricultural Nematology
- Indian Journal of Nematology - Nematological Society of India
- International Journal of Nematology - Afro-Asian Society of Nematologists, Luton
- Japanese Journal of Nematology - Japanese Nematological Society
- Journal of Nematology - Society of Nematologists, USA
- Journal of Nematode Morphology and Systematics ï Jaen, Universidad de Jaen
- Nematologia Brasiliera ï Brazilian Nematological Society
- Nematologia Mediterranea ï Istituto per la Protezione delle Plante (IPP) ï Sect. of Bari of the CNR, Italy
- Nematology - Brill Academic Publishers, UK
- Nematropica - Organization of Nematologists of Tropical America
- Pakistan Journal of Nematology - Pakistan Society of Nematologists
- Russian Journal of Nematology - Russian Society of Nematologists

e-Resources

- http://www.nematologists.org/ (The Society of Nematologists)
- http://nematology.ucdavis.edu/ (Deptt. of Nematology, Univ. of California, Davis)
- http://www.ifns.org/ (International Federation of Nematology Societies)
- http://www.inaav.ba.cnr.it/nemmed.html (Nematologia Mediterranea)
- http://nematode.unl.edu/Nemajob.htm (Nematology Employment Bulletin Board)
- http://nematode.unl.edu/ (University of Nebraska - Lincoln Nematology)
- http://nematode.unl.edu/wormsite.htm (Links to Other Nematology Resources)
- http://nematode.unl.edu/SON/jon.htm (Journal of Nematology)
- http://www.nematology.ucr.edu/ (Deptt. of Nematology, Univ. of California, Riverside)
- http://entnemdept.ifas.ufl.edu/ (Univ. of Florida, Entomology & Nematology Dept.)
- http://www.brill.nl/m_catalogue_sub6_id8548.htm (Nematology - journal)
- http://www.ars.usda.gov/main/site_main.htm?modecode=12752900 (Nematology Lab., USDA)
- http://flnem.ifas.ufl.edu/HISTORY/nem_history.htm (Nematology history)
- http://www.nematology.ugent.be/ (Nematology Unit, Ghent University)
- http://www.entm.purdue.edu/nematology/ (The Purdue Nematology Lab.)
- http://www.bspp.org.uk/ppigb/nematolo.htm#a-z (Links to Nematology labs)
- http://www.nem.wur.nl/UK/ (Laboratory of Nematology, Wageningen Univ.)
- http://onta.ifas.ufl.edu/ (The Organization of Nematologists of Tropical America)
- http://www.openj-gate.org/Articlelist.asp?Source=1&Journal_ID=103267.(Nematology Newsletter)
- http://nematology.umd.edu/nematology.html (Plant Nematology Laboratory, Maryland)
- http://www.biology.leeds.ac.uk/nem/ (Plant Nematology Lab., University of Leeds)
- http://www.plantpath.iastate.edu/dept/labs/tylka/ (Iowa State University, Nematology Lab)
- http://nematologists.org.au/newsletters.html (Australasian Association of Nematologists)
- http://soilplantlab.missouri.edu/nematode/ (Plant Nematology Laboratory, Missouri)
- http://www.eumaine.ugent.be/ (European Master of Science in Nematology)
- http://www.jstage.jst.go.jp/browse/jjn (The Japanese Journal of Nematology)

Suggested Broad Topics for Master's and Doctoral Research

- Identification of key nematode pests emerging in regional agro-ecosystems
- Development of molecular diagnostic tools of phytonematodes
- Nematode problems of peri-urban and protected agriculture systems, and their management
- Role of nematodes in organic matter recycling

- Modelling nematode populations for disease forecasting and predicting yield losses
- Nematodes as indicators of environmental pollution
- Identification of cost effective nematode-suppressive cropping systems for specific agro-ecosystems
- Isolation, identification and characterization of phytochemicals for nematoxicity
- Disinfection of nematode-infected planting material through eco-friendly sanitary methods
- Characterization of molecular markers and genes governing resistance to key nematode pests
- Management of nematodes with antagonistic bacteria
- Bionomics of potential bio-control agents and their field efficacy
- Devising non-chemical methods of nematode management in mushroom cultivation
- Development of nematode management modules for IPM systems
- Field efficacy and formulation of entomopathogenic nematodes against foliar and soil-borne insect pests of crops
- Study of disease complex involving nematodes and other plant pathogens.
- Nematode suppressive rhizospheric microorganisms.

PLANT PATHOLOGY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
PL PATH 501*	MYCOLOGY	2+1	I
PL PATH 502*	PLANT VIROLOGY	2+1	II
PL PATH 503*	PLANT BACTERIOLOGY	2+1	II
PL PATH 504*	PRINCIPLES OF PLANT PATHOLOGY	3+0	I
PL PATH 505*	DETECTION AND DIAGNOSIS OF PLANT DISEASES	0+2	I
PL PATH 506	PRINCIPLES OF PLANT DISEASE MANAGEMENT	2+1	I
PL PATH 507	DISEASES OF FIELD AND MEDICINAL CROPS	2+1	I
PL PATH 508	DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS	2+1	I
PL PATH 509	DISEASES OF VEGETABLE AND SPICE CROPS	2+1	II
PL PATH 510/ ❶ SST 510	SEED PATHOLOGY	2+1	I
PL PATH 511	CHEMICALS IN PLANT DISEASE MANAGEMENT	2+1	II
PL PATH 512	ECOLOGY OF SOIL-BORNE PLANT PATHOGENS	2+1	I
PL PATH 513/ ❶ NEMA 513	DISEASE RESISTANCE IN PLANTS	2+0	II
PL PATH 514/ ❷ ENT 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1	I
PL PATH 515	BIOLOGICAL CONTROL OF PLANT DISEASES	2+1	I
PL PATH 516	INTEGRATED PLANT DISEASE MANAGEMENT	2+1	II
PL PATH 517	MUSHROOM PRODUCTION TECHNOLOGY	2+1	II
PL PATH 518	EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES	2+1	II
PL PATH 519	POST HARVEST DISEASES	2+1	I
PL PATH 520/ ❸ ENT 520/ NEMA 514	PLANT QUARANTINE	2+0	II
PL PATH 591	MASTERôS SEMINAR	1	I, II
PL PATH 599	MASTERôS RESEARCH	20	I, II
PL PATH 601	ADVANCED MYCOLOGY	2+1	II
PL PATH 602	ADVANCED VIROLOGY	2+1	I
PL PATH 603	ADVANCED BACTERIOLOGY	2+1	II
PL PATH 604**	MOLECULAR BASIS OF HOST-PATHOGEN INTERACTIONS	2+1	II
PL PATH 605/ ❷ ENT 613/ NEMA 605	PLANT BIOSECURITY AND BIOSAFETY	2+0	I
PL PATH 691**	DOCTORAL SEMINAR I	1	I, II
PL PATH 692**	DOCTORAL SEMINAR II	1	I, II
PL PATH 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSE			
ABM 520	MANAGEMENT OF AGRO-CHEMICAL INDUSTRY	2+1	

*Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

One course of Biochemistry or G&PB of 3 credits is compulsory as Minor/Supporting

To be taught by: ❶ Plant Pathology; ❷ Entomology and Plant Pathology; ❸Entomology

PLANT PATHOLOGY

Course Contents

PL PATH 501 MYCOLOGY 2+1 SEM - I

Objective

To study the nomenclature, classification and characters of fungi.

Theory

UNIT-I: Introduction, definition of different terms, basic concepts.

UNIT-II: Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology.

UNIT-III: Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

UNIT-IV: The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi.

Practical

Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens, isolation and identification of plant pathogenic fungi.

Suggested Readings

Ainsworth GC, Sparrow FK & Susman HS. 1973. *The Fungi – An Advanced Treatise*. Vol. IV (A & B). Academic Press.

Alexopoulos CJ, Mims CW & Blackwell M.2000. *Introductory Mycology.* 5th Ed. John Wiley & Sons.

Mehrotra RS & Arneja KR. 1990. *An Introductory Mycology*. Wiley Eastern.

Sarbhoy AK. 2000. *Text book of Mycology*. ICAR.

Singh RS. 1982. *Plant Pathogens – The Fungi*. Oxford & IBH.

Webster J. 1980. *Introduction to Fungi*. 2nd Ed. Cambridge Univ. Press, Cambridge.

PL PATH 502 PLANT VIROLOGY 2+1 SEM - II

Objective

To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

Theory

UNIT-I: History of plant viruses, composition and structure of viruses.

UNIT-II: Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship.

UNIT-III: Virus nomenclature and classification, genome organization, replication and movement of viruses.

UNIT-IV: Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.

UNIT-V: Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome.

UNIT-VI: Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Practical

Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, method of raising antisera, serological tests, electron microscopy and ultratomy, PCR.

Suggested Readings

Bos L. 1964. *Symptoms of Virus Diseases in Plants*. Oxford & IBH.

Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ & Watson L. 1995. *Virus of Plants: Descriptions and Lists from VIDE Database*. CABI.

Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold.

Hull R. 2002. *Mathew's Plant Virology*. 4th Ed. Academic Press.

Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments*. Oxford & IBH.

PL PATH 503 PLANT BACTERIOLOGY 2+1 SEM - II

Objective

To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

Theory

UNIT-I: History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya, importance of phytopathogenic bacteria.

UNIT-II: Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them.

UNIT-III: Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya.

UNIT-IV: General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.

UNIT-V: Procaryotic inhibitors and their mode of action against phytopathogenic bacteria.

UNIT-VI: Survival and dissemination of phytopathogenic bacteria.

Practical

Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological characterization, isolation of plasmid and use of antibacterial chemicals/antibiotics.

Suggested Readings

Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press.

Jayaraman J & Verma JP. 2002. *Fundamentals of Plant Bacteriology*. Kalyani.

Mount MS & Lacy GH. 1982. *Phytopathogenic Prokaryotes*. Vols. I, II. Academic Press.

Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and their Management*. Angkor Publ.

Verma JP. 1998. *The Bacteria*. Malhotra Publ. House.

PL PATH 504 PRINCIPLES OF PLANT PATHOLOGY 3+0 SEM - I

Objective

To introduce the subject of Plant Pathology, its concepts and principles.

Theory

UNIT-I: Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

UNIT-II: Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

UNIT-III: Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies-oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors, altered plant metabolism as affected by plant pathogens.

UNIT-IV: Genetics of resistance; õRô genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

UNIT-V: Disease management strategies.

Suggested Readings

Agrios GN. 2005. *Plant Pathology*. 5th Ed. Academic Press.

Heitefuss R & Williams PH. 1976. *Physiological Plant Pathology*. Springer Verlag.

Mehrotra RS & Aggarwal A. 2003. *Plant Pathology*. 2nd Ed. Oxford & IBH.

Singh RS. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH.

Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants*. Oxford & IBH.

Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology*. Oxford & IBH.

PL PATH 505 DETECTION AND DIAGNOSIS OF PLANT DISEASES 0+2 SEM - I

Objective

To impart training on various methods/techniques/instruments used in the study of plant diseases/pathogens.

Practical

UNIT-I: Methods to prove Kochôs postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.

UNIT-II: Preservation of plant pathogens and disease specimens, use of haemocytometer, stage and ocular micrometer, centrifuge, pH meter, camera lucida.

UNIT-III: Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens.

Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

Suggested Readings

Baudoin ABAM, Hooper GR, Mathre DE & Carroll RB. 1990. *Laboratory Exercises in Plant Pathology: An Instructional Kit*. Scientific Publ.

Chakravarti BP. 2005. *Methods of Bacterial Plant Pathology*. Agrotech.

Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press.

Forster D & Taylor SC. 1998. *Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology*. Humana Press.

Fox RTV. 1993. *Principles of Diagnostic Techniques in Plant Pathology*. CABI.

Mathews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press.

Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments*. Cent. Agic. Pub. Doc. Wageningen.

Pathak VN. 1984. *Laboratory Manual of Plant Pathology*. Oxford & IBH.

Trigiano RN, Windham MT & Windham AS. 2004. *Plant Pathology Concepts and Laboratory Exercises*. CRC Press.

PL PATH 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT 2+1 SEM - I

Objective

To acquaint with different strategies for management of plant diseases.

Theory

UNIT-I: Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases, disease resistance and molecular approach for disease management.

UNIT-II: Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.

UNIT-III: History of fungicides, bactericides, antibiotics, concepts of pathogen immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

Practical

In vitro and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values, study of structural details of sprayers and dusters.

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press.

Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI.

Marsh RW. 1972. *Systemic Fungicides*. Longman.

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH.

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer-Verlag.

Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill.

PL PATH 507 DISEASES OF FIELD AND MEDICINAL CROPS 2+1 SEM - I

Objective

To educate about the nature, prevalence, etiology, factors affecting disease development and control measures of field and medicinal crop diseases.

Theory

UNIT-I: Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize.

UNIT-II: Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean.

UNIT-III: Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.

UNIT-IV: Diseases of Cash crops- cotton, sugarcane.

UNIT-V: Diseases of Fodder crops- berseem, oats, guar, lucerne, cowpea.

UNIT-VI: Medicinal crops- plantago, liquorice, mulathi, rosagrass, sacred basil, mentha, ashwagandha, *Aloe vera*.

Practical

Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops.

Suggested Readings

Joshi LM, Singh DV & Srivastava KD. 1984. *Problems and Progress of Wheat Pathology in South Asia*. Malhotra Publ.

Rangaswami G. 1999. *Diseases of Crop Plants in India*. 4th Ed.. Prentice Hall of India.

Ricanel C, Egan BT, Gillaspie Jr AG & Hughes CG. 1989. *Diseases of Sugarcane, Major Diseases*. Academic Press.

Singh RS. 1998. *Plant Diseases*. 7th Ed. Oxford & IBH.

Singh US, Mukhopadhyay AN, Kumar J & Chaube HS. 1992. *Plant Diseases of Internatiobnal Importance*. Vol. I. *Diseases of Cereals and Pulses*. Prentice Hall.

PL PATH 508 DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS 2+1 SEM - I

Objective

To acquaint with diseases of fruits, plantation, ornamental plants and their management.

Theory

UNIT-I: Introduction, symptoms and etiology of different fruit diseases, factors affecting disease development in fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry, citrus, mango, grapes, guava, ber, banana, pineapple, papaya, fig, pomegranate, date palm and
management of the fruits diseases.

UNIT-II: Symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management.

UNIT-III: Symptoms and life cycle of pathogen, factors affecting disease development of ornamental plants such as roses, gladiolus, tulip, carnation, orchids, marigold, chrysanthemum and their management.

Practical

Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops, collection and dry preservation of diseased specimens of important crops.

Suggested Readings

Gupta VK &.Sharma SK. 2000. *Diseases of Fruit Crops*. Kalyani Publ.

Pathak VN. 1980. *Diseases of Fruit Crops*. Oxford & IBH.

Singh RS. 2000. *Diseases of Fruit Crops*. Oxford & IBH.

Walker JC. 2004. *Diseases of Vegetable Crops*. TTPP, India.

PL PATH 509 DISEASES OF VEGETABLE AND SPICE CROPS 2+1 SEM - II

Objective

To impart knowledge about symptoms, epidemiology of different diseases of vegetables and spices and their management.

Theory

UNIT-I: Nature, prevalence, factors affecting disease development of bulb, leafy vegetable, crucifers, cucurbits and solanaceaous vegetables, diseases of protected cultivation.

UNIT-II: Symptoms and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceaous vegetable crops.

UNIT-III: Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

Practical

Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

Suggested Readings

Chaube HS, Singh US, Mukhopadhyay AN & Kumar J. 1992. *Plant Diseases of International Importance*. Vol. II. *Diseases of Vegetable and Oilseed Crops*. Prentice Hall.

Gupta SK & Thind TS. 2006. *Disease Problem in Vegetable Production*. Scientific Publ.

Gupta VK & Paul YS. 2001. *Diseases of Vegetable Crops*. Kalyani Publ.

Sherf AF & Mcnab AA. 1986. *Vegetable Diseases and their Control*. Wiley InterScience.

Singh RS. 1999. *Diseases of Vegetable Crops*. Oxford & IBH.

Walker JC. 1952. *Diseases of Vegetable Crops*. McGraw-Hill.

PL PATH 510/ SST 510 SEED PATHOLOGY 2+1 SEM - I

Objective

To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/losses and management.

Theory

UNIT-I: History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO, morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT-II: Recent advances in the establishment and subsequent cause of disease development in seed and seedling, localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT-III: Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens, epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT-IV: Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogens/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganisms.

Practical

Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field.

Suggested Readings

Agarwal VK & Sinclair JB. 1993. *Principles of Seed Pathology*. Vols. I & II, CBS Publ.

Hutchins JD & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the* 21st *Century*. CABI.

Paul Neergaard. 1988. *Seed Pathology*. MacMillan.

Suryanarayana D. 1978. *Seed Pathology*. Vikash Publ.

PL PATH 511 CHEMICALS IN PLANT DISEASE MANAGEMENT 2+1 SEM - II

Objective

To impart knowledge on the concepts, principles and judicious use of chemicals in plant disease management.

Theory

UNIT-I: History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals.

UNIT-II: Classification of chemicals used in plant disease control and their characteristics.

UNIT-III: Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals.

UNIT-IV: Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides.

UNIT-V: Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factors affecting fungicides.

UNIT-VI: General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

Practical

Acquaintance with formulation of different fungicides and plant protection appliances, formulation of fungicides, bactericides and nematicides; *in vitro* evaluation techniques, preparation of different concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; persistence, compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogens; methods of application of chemicals.

Suggested Readings

Bindra OS & Singh H. 1977. *Pesticides - An Application Equipment*. Oxford & IBH.

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control.* 3rd Ed. Oxford & IBH.

Torgeson DC (Ed.). 1969. *Fungicides*. Vol. II. *An Advanced Treatise*. Academic Press.

Vyas SC. 1993. *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill.

PL PATH 512 ECOLOGY OF SOIL-BORNE PLANT PATHOGENS 2+1 SEM - I

Objective

To provide knowledge on soil-plant disease relationship.

Theory

UNIT-I: Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi, types of biocontrol agents.

UNIT-II: Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis.

UNIT-III: Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.

Practical

Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; pathogenicity test by soil and root inoculation techniques, correlation between inoculum density of test pathogens and disease incidence, demonstration of fungistasis in natural soils; suppression of test soil-borne pathogens by antagonistic microorganisms, isolation and identification of different biocontrol agents.

Suggested Readings

Baker KF & Snyder WC. 1965. *Ecology of Soil-borne Plant Pathogens*. John Wiley.

Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. APS.

Garret SD. 1970. *Pathogenic Root-infecting Fungi*. Cambridge Univ. Press, Cambridge.

Hillocks RJ & Waller JM. 1997. *Soil-borne Diseases of Tropical Crops*. CABI.

Parker CA, Rovira AD, Moore KJ & Wong PTN. (Eds). 1983. *Ecology and Management of Soil-borne Plant Pathogens*. APS.

PL PATH 513/ NEMA 513 DISEASE RESISTANCE IN PLANTS 2+0 SEM - II

Objective

To acquaint with disease resistance mechanisms in plants.

Theory

UNIT-I: Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.

UNIT-II: Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT-III: Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

UNIT-IV: Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes, strategies for gene deployment.

Suggested Readings

Deverall BJ. 1977. *Defence Mechanisms in Plants*. Cambridge Univ. Press, Cambridge

Parker J. 2008. *Molecular Aspects of Plant Diseases Resistance*. Blackwell Publ.
Robinson RA. 1976. *Plant Pathosystems*. Springer Verlag.
Singh BD. 2005. *Plant Breeding – Principles and Methods*. 7th Ed. Kalyani Publ.
Van der Plank JE. 1975. *Principles of Plant Infection*. Academic Press.
Van der Plank JE. 1978. *Genetic and Molecular Basis of PlantPathogenesis*. Springer Verlag.
Van der Plank JE. 1982. *Host Pathogen Interactions in Plant Disease*. Academic Press.
Van der Plank JE. 1984. *Disease Resistance in Plants*. Academic Press.

PL PATH 514/ ENT 514 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 1+1 SEM - II

(To be taught jointly by Entomology and Plant Pathology)

Objective

To teach the students about the different groups of insects that are vectors of 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.

Suggested Readings

Basu AN. 1995. *Bemisia tabaci (*Gennadius*) - Crop Pest and Principal Whitefly Vector of Plant Viruses.* Oxford & IBH.
Harris KF & Maramarosh K. (Eds.).1980. *Vectors of Plant Pathogens*. Academic Press.
Maramorosch K & Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents*. Academic Press.
Youdeovei A & Service MW. 1983. *Pest and Vector Management in the Tropics*. English Language Books Series, Longman.

PL PATH 515 BIOLOGICAL CONTROL OF PLANT DISEASES 2+1 SEM - I

Objective

To study principles and application of ecofriendly and sustainable management strategies of plant diseases.

Theory

UNIT-I: Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

UNIT-II: Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

UNIT-III: Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases, compatibility of different bioagents.

UNIT-IV: Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market, quality control system of biocontrol agents.

Practical

Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen *in vitro and in vivo* conditions, study of cfu/g.

Suggested Readings

Campbell R. 1989. *Biological Control of Microbial Plant Pathogens*. Cambridge Univ. Press, Cambridge.

Cook RJ & Baker KF. 1983. *Nature and Practice of Biological Control of Plant Pathogens*. APS, St. Paul, Mennisota.

Fokkemma MJ. 1986. *Microbiology of the Phyllosphere*. Cambridge Univ. Press, Cambridge.

Gnanamanickam SS (Eds). 2002. *Biological Control of Crop Diseases*. CRC Press.

Heikki MT & Hokkanen James M (Eds.). 1996. *Biological Control - Benefits and Risks*. Cambridge Univ. Press, Cambridge.

Mukerji KG, Tewari JP, Arora DK & Saxena G. 1992. *Recent Developments in Biocontrol of Plant Diseases*. Aditya Books.

PL PATH 516 INTEGRATED PLANT DISEASE MANAGEMENT 2+1 SEM - II

Objective

To emphasize the importance and need of IDM in the management of diseases of important crops.

Theory

UNIT-I: Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

UNIT-II: Development of IDM- basic principles, biological, chemical and cultural disease management.

UNIT-III: IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearlmillet, kharif pulses, vegetable crops and fruit crops.

Practical

Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ.

PL PATH 517 MUSHROOM PRODUCTION TECHNOLOGY 2+1 SEM - II

Objective

To develop mushroom cultivation skills for entrepreneurial activity, historical development of mushroom cultivation and present status of mushroom industry in India.

Theory

UNIT-I: Historical development of mushroom cultivation and present status, taxonomy, classification, food, medicinal value, uses of mushroom, edible and poisonous mushrooms.

UNIT-II: Life cycle of cultivated mushrooms, reproduction and strain improvement, maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn lab.

UNIT-III: Preparation of substrate for mushroom cultivation, long, short and indoor composting methods, formulae for different composts and their computation, qualities and testing of compost, uses of spent mushroom compost/substrate.

UNIT-IV: Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO2, ventilation in cropping rooms, cultivation technology of *Agaricus bisporus, Pleurotus* sp., *Calocybe indica, Lentinus edodes* and *Ganoderma lucidum.*

UNIT-V: Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition, economics of mushroom cultivation, biotechnology and mushroom cultivation.

Practical

Preparation of spawn, compost, spawning, casing, harvesting and postharvest handling of edible mushroom; identification of various pathogens, competitors of various mushroom.

Suggested Readings

Chadha KL & Sharma SR. 2001. *Advances in Horticulture* (*Mushroom*). Vol. XIII. Malhotra Publ. House.

Chang ST & Hays WA. 1997. *The Biology and Cultivation of Edible Mushrooms*. Academic Press.

Chang ST & Miles PG. 2002. *Edible Mushrooms and their Cultivation*. CRC Press.

Dhar BL. 2005. *Cultivation Technology of High Temperature Tolerant White Button Mushroom*. DIPA, ICAR.

Kapur JN. 1989. *Mushroom Cultivation*. DIPA, ICAR.

PL PATH 518 EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES 2+1 SEM - II

Objective

To acquaint with the principles of epidemiology and its application in disease forecasting.

Theory

UNIT-I: Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.

UNIT-II: Common and natural logrithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.

UNIT-III: Survey, surveillance and vigilance, crop loss assessment and models.

UNIT-IV: Principles and pre-requisites of forecasting systems and factors affecting various components of forecastings, some early forecasting procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical

Measuring diseases, spore dispersal and trapping, weather recording, survey, multiplication of inoculum, computerized data analysis, function fitting, model preparation and validation.

Suggested Readings

Campbell CL & Madden LV. 1990. *Introduction to Plant Disease Epidemiology*. John Wiley & Sons.

Cowling EB & Horsefall JG. 1978. *Plant Disease*. Vol. II. Academic Press.

Laurence VM, Gareth H & Frame Van den Bosch (Eds.). *The Study of Plant Disease Epidemics*. APS, St. Paul, Minnesota.

Nagarajan S & Murlidharan K. 1995. *Dynamics of Plant Diseases*. Allied Publ.

Thresh JM. 2006. *Plant Virus Epidemiology.* Advances in Virus Research, Academic Press.

Van der Plank JE. 1963. *Plant Diseases Epidemics and Control*. Academic Press.

Zadoks JC & Schein RD. 1979. *Epidemiology and Plant Disease Management*. Oxford Univ. Press.

PL PATH 519 POST HARVEST DISEASES 2+1 SEM - I

Objective

To acquaint with post harvest diseases of agricultural produce and their ecofriendly management.

Theory

UNIT-I: Concept of post harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as preharvest and post-harvest, merits and demerits of biological control/phytoextracts in controlling post-harvest diseases.

UNIT-II: Types of post harvest problems both by biotic and abiotic causes, rhizosphere colonization, competitive, saprophytic ability, antibiosis, induced resistance, microbial associations, concept, operational mechanisms and its relevance in control.

UNIT-III: Factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro-ecocystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, comparative approaches to control of plant pathogens by resident and introduced antagonists, isolation, characterization and maintenance of pathogens, role of different storage conditions.

UNIT-IV: Integrated approach in controlling diseases and improving the shelf life of produce, control of aflatoxigenic and mycotoxigenic fungi, application and monitoring for any health hazard, knowledge of Codex Alimentarious for each product and commodity.

Practical

Isolation characterization and maintenance of pathogens, role of different storage conditions on disease development, application of antagonists against pathogens *in vivo* and *in vitro* conditions, comparative efficacy of different chemicals, fungicides, phytoextracts and bioagents.

Suggested Readings

Chaddha KL & Pareek OP. 1992. *Advances in Horticulture* Vol. IV, Malhotra Publ. House.

Pathak VN. 1970. *Diseases of Fruit Crops and their Control*. IBH Publ.

PL PATH 520/ ENT 520/ NEMA 514 **PLANT QUARANTINE** **2+0** **SEM - II**

(To be taught by Entomology)

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT-I: Definition of pest, pesticides and transgenics as per Govt. notification;relative importance; quarantine ï domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT-II: Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT-III: Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT-IV: WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Suggested Readings

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM*. Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

PL PATH 601 **ADVANCED MYCOLOGY** **2+1** **SEM - II**

Objective

To acquaint with the latest advances in Mycology.

Theory

UNIT-I: General introduction, historical development and advances in mycology.

UNIT-II: Recent taxonomic criteria, morphological criteria for classification, serological, chemical (chemotaxonomy), molecular and numerical (Computer based assessment) taxonomy.

UNIT-III: Interaction between groups: phylogeny, micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti, morphology and reproduction of representative plant pathogenic genera from different groups of fungi, sexual reproduction in different groups of fungi.

UNIT-IV: Population biology, pathogenic variability/vegetative compatibility.

UNIT-V: Heterokaryosis and parasexual cycle, sex hormones in fungi, pleomorphism and speciation in fungi, mechanism of nuclear inheritance, mechanism of extra-nuclear inheritance, biodegradation.

Practical

Study of conidiogenesis- phialides, porospores, arthospores, study of fruit bodies in Ascomycotina, identification of fungi up to species level, study of hyphal anastomosis, morphology of representative plant pathogenic genera from different groups of fungi.

Suggested Readings

Alexopoulos CJ, Mimms CW & Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons.

Dube HC. 2005. *An Introduction to Fungi*. 3rd Ed. Vikas Publ. House.

Kirk PM, Cannon PF, David JC & Stalpers JA. (Eds.). 2001. *Ainswsorth and Bisby's Dictionary of Fungi.* 9th Ed., CABI.

Ulloa M & Hanlin RT. 2000. *Illustrated Dictionary of Mycology*. APS, St. Paul, Mennisota.

Webster J & Weber R. 2007. *Introduction to Fungi*. Cambridge Univ. Press, Cambridge.

PL PATH 602 ADVANCED VIROLOGY 2+1 SEM - I

Objective

To educate about the advanced techniques and new developments in the field of Plant Virology.

Theory

UNIT-I: Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.

UNIT-II: Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.

UNIT-III: Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo, poty, bromo, cucummo, ilar and tospoviruses.

UNIT-IV: Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.

UNIT-V: Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes, viruses potential as vectors, genetically engineered resistance, transgenic plants.

UNIT-VI: Techniques and application of tissue culture, origin, evolution and interrelationship with animal viruses.

Practical

Purification of virus(es), SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing annotation of genes.

Suggested Readings

Davies 1997. *Molecular Plant Virology: Replication and GeneExpression*. CRC Press.

Fauquet *et al*. 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press.

Gibbs A & Harrison B. 1976. *Plant Virology - The Principles.* Edward Arnold.

Jones P, Jones PG & Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques*. John Wiley & Sons.

Khan JA & Dijkstra. 2002. *Plant Viruses as Molecular Pathogens*. Howarth Press.

Maramorosch K, Murphy FA & Shatkin AJ. 1996. *Advances in Virus Research*. Vol. 46. Academic Press.

Pirone TP & Shaw JG. 1990. *Viral Genes and Plant Pathogenesis*. Springer Verlag.

Roger Hull 2002. *Mathew's Plant Virology* (4th Ed.). Academic Press.

Thresh JM. 2006. *Plant Virus Epidemiology.* Advances in Virus Research. Academic Press.

PL PATH 603 ADVANCED BACTERIOLOGY 2+1 SEM - II

Objective

To provide knowledge about the latest advances in phytobacteriology.

Theory

UNIT-I: Current approaches for the characterization and identification of phytopathogenic bacteria, ultrastructures and biology of bacteria.

UNIT-II: Current trends in taxonomy of phytopathogenic procarya.

UNIT-III: Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development, mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumifaciens*).

UNIT-IV: Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

UNIT-V: Molecular variability among phytopathogenic procarya and possible host defense mechanism(s), genetic engineering for management of bacterial plant pasthogens-gene silencing, RNAi technology.

UNIT-VI: Epidemiology in relation to bacterial plant pathogens, development of diagnostic kit.

UNIT-VII: Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management, endosymbionts for host defence.

Practical

Pathogenic studies and race identification; plasmid profiling of bacteria;fatty acid profiling of bacteria; RAPD prolfiling of bacteria and variability status; Endospore, Flagiler staining; test for secondary metabolite production, cyanides, EPS, siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers, basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.

Suggested Readings

Dale JW & Simon P. 2004. *Molecular Genetics of Bacteria*. John Wiley & Sons.

Garrity GM, Krieg NR & Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria.* Vol. II. Springer Verlag.

Gnanamanickam SS. 2006. *Plant-Associated Bacteria*. Springer Verlag.

Mount MS & Lacy GH. 1982. *Plant Pathogenic Prokaryotes*. Vols. I, II. Academic Press.

Sigee DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects*. Cambridge Univ. Press, Cambridge.

Starr MP. 1992. *The Prokaryotes*. Vols. I ï IV. Springer Verlag.

PL PATH 604 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTIONS 2+1 SEM - II

Objective

To understand the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.

Theory

UNIT-I: Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.

UNIT-II: Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

UNIT-III: Induction of defense responses- pathogenesis related proteins, HR, reactiveoxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing.

UNIT-IV*:* Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

UNIT-V: Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical

Protein, DNA and RNA isolation, plasmids extraction,PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

Suggested Readings

Chet I. 1993. *Biotechnology in Plant Disease Control*. John Wiley & Sons.

Gurr SJ, Mc Pohersen MJ & Bowlos DJ. (Eds.). 1992. *Molecular Plant Pathology - A Practical Approach.* Vols. I & II, Oxford Univ. Press, Oxford.

Mathew JD. 2003. *Molecular Plant Pathology*. Bios Scientific Publ.

Ronald PC. 2007. *Plant-Pathogen Interactions: Methods in Molecular Biology*. Humana Press.

Stacey G & Keen TN. (Eds.). 1996. *Plant Microbe Interactions*. Vols. I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

PL PATH 605/ ENT 613/ NEMA 605 **PLANT BIOSECURITY AND BIOSAFETY** **2+0** **SEM - I**

(To be taught jointly by Entomology and Palnt Pathology)

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT-I: History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT-II: National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT-III: Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008. www.fao.org/docrep/010/a1140e/a1140e00.htm

Laboratory Biosecurity Guidance.
http://www.who.int/csr/resources/publications/biosafety/
WHO_CDS_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan.*
http://www.americanprogress.org/kf/biosecurity_a_comprehensive_ action_plan.pdf

*Biosecurity Australia.*www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia.

Biosecurity New Zealand. www.biosecurity.govt.nz

DEFRA.www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns.* NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production. http://www.fao.org/biosecurity/

CFIA.http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml

PLANT PATHOLOGY

List of Journals

- *Annals of Applied Biology* ï Cambridge University Press, London
- *Annual Review of Phytopathology* ï Annual Reviews, Palo Alto, California
- *Annual Review of Plant Pathology* - Scientific Publishers, Jodhpur
- *Canadian Journal of Plant Pathology* - Canadian Phytopathological Society, Ottawa
- *Indian Journal of Biotechnology* - National Institute of Science Communication and Information Resources, CSIR, New Delhi
- *Indian Journal of Mycopathological Research*- Indian Society of Mycology, Kolkata.
- *Indian Journal of Virology* - Indian Virological Society, New Delhi
- *Indian Phytopathology* - Indian Phytopathological Society, New Delhi
- *Journal of Mycology and Plant Pathology* - Society of Mycology and Plant Pathology, Udaipur
- *Journal of Phytopathology* - Blackwell Verlag, Berlin
- *Mycologia* - New York Botanical Garden, Pennsylvania
- *Mycological Research* - Cambridge University Press, London
- *Physiological Molecular Plant Pathology* - Academic Press, London
- *Phytopathology* - American Phytopathological Society, USA
- *Plant Disease* - The American Phytopathological Society, USA
- *Plant Disease Research* ï Indian Society of Plant Pathologists, Ludhiana
- *Plant Pathology* - British Society for Plant Pathology, Blackwell Publ.
- *Review of Plant Pathology* - CAB International, Wallingford
- *Virology*- New York Academic Press

e-Resources

- www.shopapspress.org
- www.apsjournals.apsnet.org
- www.apsnet.org/journals
- www.cabi_publishing.org
- www.springer.com/life+Sci/agriculture
- www.backwellpublishing.com
- www.csiro.au
- www.annual-reviews.org

Suggested Broad Topics for Master's and Doctoral Research

- Pathogenesis and characterization of plant pathogens
- Survey and surveillance
- Induction of resistance using biotic and abiotic elicitors
- Variability in plant pathogens
- Plant-Virus-Vector relationships
- Genome organization of plant pathogens
- Dynamics of plant pathogen propagules and their biology
- Molecular tools in disease diagnosis
- Molecular mechanisms of pathogenesis in crops and seeds
- Rhizosphere in pathogenesis of seed-borne plant pathogens
- Transgenic resistance
- Development of disease prediction models in disease forecasting
- Integrated Disease Management
- Molecular Taxonomy of different plant pathogens
- Development of Rapid Diagnostic methods
- Development and Formulation of Improved Biocontrol Agent

SEED SCIENCE AND TECHNOLOGY

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
SST 501*	FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION	1+1	I
SST 502*	PRINCIPLES OF SEED PRODUCTION	2+0	I
SST 503*	SEED PRODUCTION IN FIELD CROPS	2+1	I
SST 504/ ❶ VSC 505	SEED PRODUCTION IN VEGETABLES	2+1	II
SST 505 ❷	SEED PRODUCTION IN FLOWER, MEDICINAL FRUITS AND PLANTATION CROPS	2+1	I
SST 506*	SEED LEGISLATION AND CERTIFICATION	2+1	II
SST 507*/ ❸ PFE 514	SEED DRYING, PROCESSING AND STORAGE	2+1	II
SST 508*	SEED QUALITY TESTING	2+1	II
SST 509/ ❹ PP 511	SEED PHYSIOLOGY	1+1	I
SST 510/ ❺ PL PATH 510	SEED PATHOLOGY	2+1	I
SST 511 ❻	SEED ENTOMOLOGY	2+1	II
SST 512	SEED PRODUCTION IN PASTURE, FORAGE AND GREEN MANURE CROPS	2+1	II
SST 513	SEED STORAGE AND DETERIORATION	1+1	II
SST 514/ ❼ AG ECON 510	SEED MARKETING AND MANAGEMENT	2+1	II
SST 515	EMERGING TRENDS IN SEED QUALITY ENHANCEMENT	1+1	I
SST 516/ ❽ GP 517	DATA BASE MANAGEMENT, EVALUATION AND UTILIZATION OF PGR	2+1	II
SST 591	MASTERôS SEMINAR	1	I, II
SST 599	MASTERôS RESEARCH	20	I, II
SST 601**	HYBRID SEED PRODUCTION	1+1	II
SST 602/ ❽ GP 610	*IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM	2+1	II
SST 603	TESTING FOR GENUINENESS AND PURITY OF CULTIVARS	1+1	I
SST 604**	DUS TESTING FOR PLANT VARIETY PROTECTION	2+1	I
SST 605**	ADVANCES IN SEED SCIENCE RESEARCH	1+0	II
SST 691	DOCTORAL SEMINAR I	1	I, II
SST 692	DOCTORAL SEMINAR II	1	I, II
SST 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSE			
ABM 522	SEED PRODUCTION TECHNOLOGY AND MANAGEMENT	2+0	

*Compulsory for Masterôs programme; ** Compulsory for Doctoral programme

To be taught by: ❶ Vegetable Science; ❷ Fruit Science ❸ Processing & Food Engineering; ❹ Botany & Plant Physiology; ❺ Plant Pathology; ❻ Entomology; ❼ Agricultural Economics; ❽ Genetics & Plant Breeding

SEED SCIENCE AND TECHNOLOGY

Course Contents

SST 501 FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION 1+1 SEM - I

Objective

To refresh the basic knowledge of seed development and structures and apprise students with its relevance to production of quality seed.

Theory

UNIT-I: Floral types, structure and biology in relation to pollination mechanisms; sporogenesis: microsporogenesis and megasporogenesis; gametogenesis - development of male and female gametes and their structures; effect of environmental factors on floral biology.

UNIT-II: Fertilization ï embryo sac structure, process, barriers to fertilization, incompatibility and male sterility, factors affecting fertilization.

UNIT-III: Embryogenesis - development of typical monocot and dicot embryos; endosperm development, modification of food storage structures with reference to crop plants; different types of embryos, endosperm and cotyledons; development and their structure in representative crop plants with reference to food storage; external and internal features of monocot and dicot seed; seed coat structure and development in representative crop plants.

UNIT-IV: Apomixis ï identification, classification, significance and its utilization in different crops for hybrid seed production; Polyembryony - types and significance; haplontic and diplontic sterility, causes of embryo abortion, embryo rescue and synthetic seeds.

Practical

Study of floral biology of monocots and dicots; microsporogenesis and megasporogenesis; study of pollen grains - pollen morphology, pollen germination and pollen sterility; types monocot and dicot embryos; external and internal structures of monocot and dicot seeds; seed coat structure, preparation of seed albums and identification.

Suggested Readings

Bhojwani SS & Bhatnagar SP. 1999. *The Embryology of Angiosper*m. Vikas Publ.

Black M, Bewley D & Halmer P. 2006. *The Encyclopedia of Seeds: Science, Technology and Use*s. CABI.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plant*s. Deptt. of Plant Breeding, CCS HAU, Hisar.

Copeland LO & McDonald MB. 2001. *Principles of Seed Science and Technolog*y. 4th Ed. Chapman & Hall.

Frankel R & Galun E. 1977. *Pollination Mechanisms, Reproduction and Plant Breedin*g. Springer Verlag.

SST 502 PRINCIPLES OF SEED PRODUCTION 2+0 SEM - I

Objective

To introduce the basic priciples of quality seed production.

Theory

UNIT-I: Introduction : Seed as basic input in agriculture; seed development in cultivated plants; seed quality concept and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration; seed production in self and cross pollinated crops.

UNIT-II: Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

UNIT-III: Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production ï agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of Nucleus seed, production of Breeder, Foundation and

Certified seedï criteria involved; life span of a variety and causes for its deterioration; certification standards for self and cross pollinated and vegetatively propagated crops.

UNIT-IV: Hybrid Seed - Methods of development of hybrids; use of male sterility and self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.

UNIT-V: Planning of seed production for different classes of seeds for self and cross-pollinated crops, Seed quality control system and organization, seed village concept; Seed production agencies, seed industry and custom seed production in India.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plant*s. Dept. of Plant Breeding CCS HAU, Hisar.

Desai BB. 2004. *Seeds Handboo*k. Marcel Dekker.

Kelly AF. 1988. *Seed Production of Agricultural Crop*s. Longman.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practice*s. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seed*s. Handbook No. 219, USDA, Washington, DC, USA.

Poehlman JM & Sleper DA. 2006. *Breeding Field Crop*s. Blackwell.

Singh BD. 2005. *Plant Breeding: Principles and Method*s. Kalyani.

Singhal NC. 2003. *Hybrid Seed Production in Field Crop*s. Kalyani.

Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.

Tunwar NS & Singh SV. 1985. *Handbook of Cultivar*s. CSCB, GOI.

SST 503 SEED PRODUCTION IN FIELD CROPS 2+1 SEM - I

Objective

To impart a comprehensive knowledge of seed production in field crops with adequate practical training.

Theory

UNIT-I: Basic principles in seed production and importance of quality seed. Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets viz, wheat, barley, paddy, ragi etc.

UNIT-II: Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets viz maize, sorghum, bajra etc ; methods and techniques of quality seed production in cross-pollinated cereals and millets.

UNIT-III: Floral structure, breeding and pollination mechanism; methods and techniques of seed production in pulses (pigeon pea, chick pea, green garm, black garm, field beans, peas etc.).

UNIT-IV: Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, castor, sunflower, safflower, rape and mustard, linseed, sesame etc.).

UNIT-V: Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute, mesta etc) and vegetatively propagated crops like sugar cane, potato etc.

Practical

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate; Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, hand emasculation and pollination in Cotton, detasseling in Corn, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc.

Suggested Readings

Kelly AF. 1988. *Seed Production of Agricultural Crop*s. John Wiley.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practice*s. Chapman & Hall.

Singhal NC. 2003. *Hybrid Seed Production in Field Crop*s. Kalyani.

SST 504/ VSC 505 **SEED PRODUCTION IN VEGETABLES** **2+1** **SEM - II**
(To be taught by Vegetable Science)

Objective

To impart a comprehensive knowledge of seed production in vegetable crops with adequate practical training.

Theory

UNIT-I: Introduction; modes of propagation in vegetables. Seed morphology and development in vegetable seeds. Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops.

UNIT-II: Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. seed-to-seed vs. root-to-seed method in radish; seed multiplication ratios in vegetables; pollination mechanisms; sex types, ratios and expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage.

UNIT-III: Seed production technology of vegetables viz. solanaceous, cucurbitaceous, leguminous, malvaceous, cole crops, leafy vegetables, root, tuber and bulb crops and spices; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato, sweet potato, colocasia, tapioca; seed-plot technique in potato tuber seed production; hybrid seed production technology of vegetable crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self incompatibility in hybrid seed production, environmental factors related to flowering/bolting in vegetable crops.

UNIT-IV: Share of vegetable seeds in seed industry; importance and present status of vegetable industry; intellectual property rights and its implications, impact of PVP on growth of seed industry.

Practical

Selection of suitable areas/locations for high quality seed/planting material production; study of floral biology of vegetables, determination of planting ratios for hybrid seed production in vegetables; use and maintenance of monoecious line in hybrid seed production of cucumber; exercises on emasculation and pollination; seed extraction methods and their effect on quality seed of vegetables; seed production technology of varieties and hybrids in vegetables.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Desai BB, Katecha, PM & Salunke DK.1997. *Seed Hand Book: Biology,Production, Processing and Storag*e. Marcel Dekker.

Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.

George RAT. 1980. *Vegetable Seed Technology. A Technical Guide to Vegetable Seed Production, Processing, Storage and Quality Control.* FAO, Rome.

Hartman HT & Kester DE. 2000. *Plant Propagation: Principles and Practice*s. Prentice Hall.

Kelly AF & George RAT. (Eds.).1998. *Encyclopedia of Seed Production of World Crop*s. John Wiley & Sons.

McDonald MB Jr & Copeland LO. 1997. *Seed Production of Crops: Principles and Practice*s. Chapman & Hall.

Salunkhe DK, Desai BB & Bhat RN. 1987. *Vegetable and Flower Seed Productio*n. Agricole Publ. Academy.

Singh SP. 2001. *Seed Production of Commercial Vegetable*s. Agrotech.

Singhal NC. 2003. *Hybrid Seed Production in Field Crop*s. Kalyani.

SST 505 **SEED PRODUCTION IN FLOWERS, MEDICINAL, FRUITS AND PLANTATION CROPS** **2+1** **SEM - I**
(To be taught by Fruit Science)

Objective

To impart comprehensive knowledge of seed production in horticultural crops with adequate practical training.

Theory

UNIT-I: Introduction: modes of propagation in fruits, flower and plantation crops. Floral biology of these plant species; classification of medicinal and horticultural crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops.

UNIT-II: Flowers and Medicinal Plants; classification based on growth cycle, reproduction and pollination behavior; nursery requirement, planning and management; technology for quality seed production in important flower species i.e. marigolds, petunias, dahlia, roses, gladiolus, tulips, chrysanthemum etc; development of hybrids and their seed production technology of flower plants. Seed production technology of annual medicinal plants viz. isabgol, ashawagandha etc.

UNIT-III: Fruit and Plantation Crops: role of seed in perennial plant species; classification based on reproduction and pollination behavior; polyembryony and its significance; nursery requirement, planning and management; clonal propagation and multiplication in tropical, sub-tropical and temperate fruits and plantation crops; seed orchards; seed collection, extraction and processing.

UNIT-IV: IPR issues with special reference to floral and plantation crops.

Practical

Selection of suitable areas/locations for high quality seed/planting material production; study of floral biology of flowers, fruits, medicinal and plantation crops; determination of planting ratios for hybrid seed production in flowers; exercises on emasculation and pollination; seed extraction methods and their effect on seed quality of fruit; seed production technology of varieties and hybrids; seed collection and extraction in fruit and plantation crops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Desai BB, Katecha, PM & Salunke DK.1997. *Seed Hand Book: Biology, Production, Processing and Storage*. Marcel Dekker.

Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.

Doijode SD. 2001. *Seed Storage of Horticultural Crops*. CBS.

George RAT. 1980. *Vegetable Seed Technology. A Technical Guide to Vegetable Seed Production, Processing, Storage and Quality Control.* FAO, Rome.

Hartman HT & Kester DE. 2000. *Plant Propagation: Principles and Practices*. Prentice Hall.

ICAR. *Hand Book of Horticulture.* ICAR.

Kelly AF & George RAT. (Eds.).1998. *Encyclopedia of Seed Production of World Crops*. John Wiley & Sons.

McDonald MB Jr & Copeland LO. 1997. *Seed Production of Crops: Principles and Practices*. Chapman & Hall.

Salunkhe DK, Desai BB & Bhat RN. 1987. *Vegetable and Flower Seed Production*. Agricole Publ. Academy.

Singh SP. 2001. *Seed Production of Commercial Vegetables*.Agrotech.

Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

SST 506 SEED LEGISLATION AND CERTIFICATION 2+1 SEM - II

Objective

To apprise students with the legislative provisions and processes and the mechanisms of seed quality control.

Theory

UNIT-I: Historical development of Seed Industry in India; Seed quality: concept and factors affecting seed quality during different stages of production, processing and handling; seed quality control- concept and objectives; Central Seed Certification Board (CSCB).

UNIT-II: Regulatory mechanisms of seed quality control- organizations involved in seed quality control programmes; seed legislation and seed law enforcement as a mechanism of seed quality control; the Seed Act (1966), Seed Rules (1968), Seed (Control) Order 1983; Essential Commodities Act (1955); Plants, Fruits and Seeds Order (1989); National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials; New Seed Bill-2004 etc. Introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

UNIT-III: Seed Certification- history, concept and objectives of seed certification; seed certification agency/organization and staff requirement; legal status and phases of seed certification; formulation, revision and publication of seed certification standards; Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including GM varieties, field and seed standards; planning and management of seed certification programmes- eligibility of a variety for certification, area assessment, cropping history of the seed field, multiplication system based on limited generation concept, isolation and land requirements etc.

UNIT-IV: Field Inspection- principles, phases and procedures; reporting and evaluation of observations; pre and post-harvest control tests for genetic purity evaluation (grow-out tests); post harvest inspection and evaluation; seed sampling, testing, labeling, sealing and grant of certificate; types and specifications for tags and labels; maintenance and issuance of certification records and reports; certification fee and other service charges; training and liaison with seed growers. OECD seed certification schemes.

UNIT-V: Introduction to WTO and IPRs; Plant Variety Protection and its significance; UPOV and its role; DUS testing- principles and applications; essential features of PPV & FR Act, 2001 and related Acts.

Practical

General procedure of seed certification ; identification of weed and other crop seeds as per specific crops; field inspection at different stages of a crop and observations recorded on contaminants and reporting of results; inspection and sampling at harvesting/threshing, processing and after processing for seed law enforcement; testing physical purity, germination and moisture; specifications for tags and labels to be used for certification purpose; grow-out tests for pre and post-harvest quality control; visits to regulatory seed testing laboratory, including plant quarantine lab and seed certification agency.

Suggested Readings

Agarwal RL. 1997. *Seed Technolog*y. Oxford & IBH.

Anonymous 1992. *Legislation on Seed*s. NSC Ltd., Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.

Nema NP. 1986. *Principles of Seed Certification and Testin*g. Allied Publs.

Tunwar NS & Singh SN. 1988. *Indian Minimum Seed Certification Standard*s. CSCB, Ministry of Agriculture, New Delhi.

SST 507/ PFE 514 **SEED DRYING, PROCESSING AND STORAGE** **2+1** **SEM - II**

(To be taught by Processing and Food Engineering)

Objective

To acquaint the students with drying and processing of seeds, operation and maintenance of different seed processing machinery and dryers .

Theory

UNIT-I: Principles and importance of seed processing, preparation of seeds before processing, machines used to prepare seed for processing (Delinters, extractors, debearder, sacrifier etc.)

UNIT-II: Operation maintenance of different seed processing machinery such as air screen cleaner, indented cylinder, dise separator, gravity separator, pneumatic separator, surface texture equipment, shape, size, colour sorter, magnetic separator, electrostatic separator, seed conveying, different types of conveyers, seed treating, and treaters.

UNIT-III: Seed drying - principles and methods, E.M.C. Theory of drying, calculation of drying time, different types of heated air dryers, importance of scientific seed storage, types of storage structures, methods of maintaining safe seed moisture, thumb rule and its relevance, management and operation/ cleanliness of seed store, design features of medium and long term seed storage structures.

UNIT-IV: Seed packaging, principles, practices, materials, weighing and bagging machines, their operation and maintenance, seed quality maintenance during processing, Plant design and lay out, safety considerations in plant design.

Practical

Operation and performance evaluation of various seed processing equipments such as pre cleaner, scalpers, air screen cleaner, indented cylinder, gravity separator, pneumatic separator, colour sorter and other equipments, seed treater, conveyors and elevators, bag closers, different types of dryers, design and layout of seed processing plant and its

economics, analysis of cost of operation and processing, determination of seed moisture, seed germination and vigour.

Suggested Readings

Gregg et al. 1970. *Seed Processing*. NSC.

Henderson S & Perry SM. 1976. *Agricultural Process Engineering*. 5th Ed. AVI Publ. Co.

Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.

SST 508 SEED QUALITY TESTING 2+1 SEM - II

Objective

To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

UNIT-I: Introduction: Structure of monocot and dicot seeds; seed quality:objectives, concept and components and their role in seed quality control; instruments, devices and tools used in seed testing. ISTA and its role in seed testing.

UNIT-II: Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling devices; procedure of seed sampling; sampling intensity; methods of preparing composite and submitted samples; sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.

UNIT-III: Physical Purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other seed by number per kilogram; determination of other distinguishable varieties (ODV); determination of test weight and application of heterogeneity test.

UNIT-IV: Seed moisture content: importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation - types, instruments and devices used; pre-drying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results.

UNIT-V: Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; working sample and choice of method; general procedure for each type of method; duration of test; seedling evaluation; calculation and reporting of results; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy.

UNIT-VI: Viability and Vigour Testing: definition and importance of viability tests; different viability tests; quick viability test (TZ- test) - advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing: concept, historical development, definitions, principles and procedures of different methods used for testing vigour.

UNIT-VII: Genetic purity testing : objective and criteria for genetic purity testing; types of tests; laboratory, Growth Chamber and field testing based on seed , seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests.

UNIT-VIII: Seed health Testing: field and seed standards ; designated diseases, objectionable weeds - significance of seed borne diseases vis-a-vis seed quality - seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes.

UNIT-IX: Testing of GM seeds and trait purity, load of detection (LOD).

UNIT X: Preparation and dispatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances.

Practical

Structure of monocot and dicot seeds of important plant species; identification and handling of instruments used in seed testing laboratory; identification of seeds of weeds and crops; physical purity analysis of samples of different crops; estimation of seed moisture content (oven method); seed dormancy breaking methods, requirements for conducting germination test, specifications and proper use of different substrata for germination; seed germination testing in different agri-horticultural crops; seedling evaluation; viability testing by tetrazolium test in different crops; seed and seedling vigour

tests applicable in various crops; species & cultivar identification; genetic purity testing by chemical, biochemical and molecular methods; seed health testing for designated diseases, blotter methods, agar method and embryo count methods; testing coated/pelleted seeds.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. Oxford & IBH.

Agrawal PK & Dadlani M.1992. *Techniques in Seed Science and Technology*. 2nd Ed. South Asian Publ.

Agrawal PK. (Ed.). 1993. *Handbook of Seed Testing*. Ministry of Agriculture, GOI, New Delhi.

Copland LO & McDonald MB. 199*6. Principles of Seed Science and Technology*. Kluwer.

ISTA 2006. *Seed Testing Manual*. ISTA, Switzerland.

Martin C & Barkley D. 1961. *Seed Identification Manual*. Oxford & IBH.

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

SST 509/ PP 511 **SEED PHYSIOLOGY** **1+1** **SEM - I**

(To be taught by Botany & Plant Physiology)

Objective

To provide an insight into physiological processes governing seed quality and its survival.

Theory

UNIT-I: Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.

UNIT-II: Seed germination; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization and inter-conversion pathways. Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy.

UNIT-III: Seed viability and longevity, pre and post-harvest factors affecting seed viability ; seed ageing ; physiology of seed deterioration ; lipid peroxidation and other viability theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.

UNIT-IV: Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield. Seed invigoration and its physiological and molecular control.

Practical

Proximate analysis of chemical composition of seed; methods of testing viability; kinetics of seed imbibition and solute leakage; seed germination and dormancy breaking methods; seed invigoration and priming treatments; accelerated ageing and controlled deterioration tests; enzymatic activities and respiration during germination and effect of accelerated ageing; vigour testing methods etc.

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Baskin CC & Baskin JM. 1998. *Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination*. Academic Press.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food Product Press.

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. Food Product Press.

Bewley JD & Black M. 1982. *Physiology and Biochemistry of Seeds in Relation to Germination*. Vols. I, II. Springer Verlag.

Bewley JD & Black M. 1985. *Seed: Physiology of Seed Development and Germination*. Plenum Press.

Copeland LO & Mc Donald MB. 1995. *Principles of Seed Science and Technology*. 3rd Ed. Chapman & Hall.

Khan AA. 1977. *Physiology and Biochemistry of Seed Dormancy and Germination*. North Holland Co.

Kigel J & Galili G. (Eds.). *Seed Development and Germination*. Marcel Dekker.

Murray DR. 1984. *Seed Physiology.* Vols. I, II. Academic Press.

Sadasivam S & Manickam A. 1996. *Biochemical Method*s. 2nd Ed. New Age.

SST 510/ PL PATH 510 **SEED PATHOLOGY** **2+1** **SEM - I**

(To be taught by Plant Pathology)

Objective

To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/losses and management.

Theory

UNIT-I: History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT-II: Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT-III: Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT-IV: Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical

Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field.

Suggested Readings

Agarwal VK & JB Sinclair. 1993. *Principles of Seed Pathology*. Vols. I & II, CBS Publ.

Hutchins JD & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI.

Paul Neergaard. 1988. *Seed Pathology*. MacMillan.

Suryanarayana D. 1978. *Seed Pathology*. Vikash Publ.

SST 511 **SEED ENTOMOLOGY** **2+1** **SEM - II**

(To be taught by Entomology)

Objective

To apprise about the role of insects in seed production and their effect on seed quality during storage.

Theory

UNIT-I: Principles of seed entomology; pollinator insects, insect pests and their classification based on mode of infestation etc.

UNIT-II: Principles of insect pollination, role of pollinators in seed production. Augmenting quality seed production through honeybee pollination in crucifers and forage legumes. Plant protection measures in bee pollinated crops. Management of pollinators for hybrid seed production.

UNIT-III: Major insect pests of principal crops and their management practices. Methods of insect pest control. Classes of pesticides, their handling and safe use on seed crops.

UNIT-IV: Storage insect pests infecting seeds, their development and economic importance. Storage losses due to pests, control of storage pests, Management of storage insects pests, mites and rodents, seed sampling and loss estimation.

UNIT-V: Principles of fumigation and their use, effect of different fumigants; preservatives and seed protectants on seed quality; Type of storage structures ï domestic and commercial.

Practical

Collection and identification of insect-pollinators, collection and identification of important pests of stored seeds. Detection and estimation of pest infestation vis- a- vis loss of seed quality. Safe handing and use of fumigants and insecticides ; safety measures in fumigating and disinfecting , exposure period, aeration etc. the storage structures. Plant protection equipments, their operation and maintenance. Pesticides, its dose determination, preparation of solution and its application.

Suggested Readings

Agarwal NA & Girish GK. 1977. *An Introduction to Action Programme to Regress on Farm Storage Losses in Indi*a. FAO/NORAD Seminar on Farm Storage Grain in India, Nov. 29-Dec. 8, 1977.

Anderson JA & Aleock AW. 1954. *Storage of Cereal Grain & their Product*s. American Assoc. Cereal Chemists, St. Pauls, Minn.

Cottong RT. 1963. *Insect Pests of Stored Grain and Grain Product*s. Burgess Publ. Co., Minneopolis, Minn., USA.

Monro 1969. *Manual of Fumigation for Insect Contro*l. FAO Rome Agril. Studies No. 79.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Product*s. Marcel Dekker.

SST 512 SEED PRODUCTION IN FORAGE, PASTURE AND GREEN MANURE CROPS 2+1 SEM - II

Objective

To apprise about the basic requirements and methods of quality seed production in forage, pasture and green manure crops.

Theory

UNIT-I: Important pasture and forage legume crops in India; seed requirement and production; classification of forage, pastures and green manure crops; pollination behavior.

UNIT-II: Factors influencing seed production; maintenance of varietal purity, generation systems of seed multiplication in self pollinated crops; seed production in apomictic grasses.

UNIT-III: Methods and techniques of seed production in important grasses, pastures, legumes and green manure crops; apomictic seed.

UNIT-IV: Selection of seed production areas, influence of season, seed rate and spacing, sowing methods, direct seed sowing, transplanting, pelleting, fertilizer and manure requirement, isolation distance, weed control, pollination and seed setting, seed shattering, seed maturity and stage of harvest, seed collection, economics of seed production of important fodder crops.

UNIT-V: Seed processing, seed treatment, seed storage, seed viability of these crops.

Practical

Study of flower structure, seed collection and identification, characteristics of forage, pastures and green manure crops; maturity indices for harvest, seed testing- sampling, purity, moisture, germination and dormancy, seed treatments.

Suggested Readings

Farity DT & Hampton JC. 1997. *Forage Seed Productio*n. Vol. I. *Temperate specie*s. CABI.

Froma J. 1997. *Temperate Forage Legume*s. CABI.

Gutterridge RG. 1997. *Forage Tree Legumes in Tropical Agricultur*e. CABI.

*Quality Declared Seed Syste*m. 2007. FAO Plant Production and Protection Publication No.185: FAO, Rome.

SST 513 SEED STORAGE AND DETERIORATION 1+1 SEM - II

Objective

To provide understanding of the mechanism of seed ageing during storage, factors affecting it and its control.

Theory

UNIT-I: Life span of seeds of plant species; classification of seeds on the basis of storage behaviour; orthodox and recalcitrant seeds; types of storage; kinds of seed storage (open, bulk, controlled, hermetic, germplasm, cryopreservation); soil seed bank; terminology; survival curve of seed.

UNIT-II: Factors affecting seed storability- biotic and abiotic and pre- and post-harvest factors affecting seed longevity; the effects of packaging materials, storage fungi and insects, seed treatment and fumigation and storage environmental conditions on seed storability; moisture equilibrium in seeds; hysteresis effect; thumb rules; selection of suitable areas/places for safe storage; prediction of relative storability and longevity of seed lots, viability equations and nomographs.

UNIT-III: Concept of seed ageing and deterioration, its causes, symptoms, mechanisms and related theories; different changes associated with the loss of vigour and viability during storage; application of physiological and biochemical techniques for evaluation of seed ageing; genetics of seed viability; effect of seed ageing on crop performance; maintenance of viability and vigour during storage; seed amelioration techniques, mid storage corrections etc.

UNIT-IV: Storage methods- requirement of storage facilities in India; types and storage structures available in the country and their impact on short and long term storage; methods of safe seed storage including eco-friendly techniques used in various group of crops viz. cereals, pulses, oilseeds, fibers, forages and vegetables; operation and management of seed stores; fruit storage; viability loss during transportation and interim storage.

Practical

To study the effect of storage environmental factors (RH, SMC and temperature) on seed longevity; to study the effect of packaging materials, seed treatment and fumigation on storability; prediction of storability and longevity of seed-lots by using viability equations and nomographs; standardization of accelerated ageing (AA) technique for assessing the seed storability of various crops; estimation of carbohydrates, proteins, fats, enzyme activities, respiration rate and nucleic acids in fresh and aged seeds; use of eco-friendly products and amelioration techniques to enhance quality of stored seeds, visit to seed stores.

Suggested Readings

Barton LV. 1961. *Seed Preservation and Longevit*y. Burgess Publ.

Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implication*s. Food Products Press.

Basra AS. 2006. *Handbook of Seed Science and Technolog*y. Food Product Press.

Desai BB. 2007. *Seed Handbook: Biology, Production, Processing and Storag*e. Marcel Dekker.

Doijode SD. 2001. *Seed Storage of Horticultural Crop*s. CBS.

Justice OL & Bass LN. 1978. *Principles and Practices of Seed Storag*e. Castle House Publ.

Kharb RPS & Kharb P. 1997. Biochemical and Cytogenetical Changes

During Storage. In: *Seed Technology* (Eds. BS Dahiya & KN Rai): pp. 160-168.

McDonald MB & Roos EE. (Eds.). 1986. *Physiology of Seed Deteriorati*on. Paper No. 11, Crop Science Society of America, USA.

Roberts EH. 1972. *Viability of Seed*s. Chapman & Hall.

SST 514/ AG ECON 510 **SEED MARKETING AND MANAGEMENT** **2+1** **SEM - II**

(To be taught by Agricultural Economics)

Objective

To train the students regarding economic concepts of seed marketing in India and role of Government in development of efficient seed marketing system.

Theory

UNIT-I: Basic concepts of agricultural marketing, seed marketing, importance and scope of seed industry in India, major constraints/problems in seed industry/seed sector.

UNIT-II: Demand and supply of seed, cost of production and returns and factors determining seed needs, pricing policies, seed pricing and price policies, seed processing and packing/packaging.

UNIT-III: Purpose and approaches to seed marketing; Seed marketing mix, sales promotion, distribution channels, marketing costs and margins; Market research information and segmentation.

UNIT-IV: Policy environment for sustainable growth of seed sector in India. Salient features of proposed seed act and national seed policy, role of government in efficient seed marketing, quality control and assurance. WTO and seed industry in India.

Practical

Estimation of cost of seed production, marketing costs and margins of seeds of different crops. Estimation of seed demand and supply, seed forecasting techniques, marketing plan.

Suggested Readings

Kohls RL & Uhl JN. *Marketing of Agril. Products*. Prentice Hall.

Pingali Venugopal, 2004. *State of Indian Farmer: A Millennium Study*, Volume 8: *Input Management*. Academic Foundation, Department of Agriculture, and Cooperation, Ministry of Agriculture, GOI, New Delhi.
Premjit Sharma (Ed.). 2008. *Marketing of Seeds*. Gene-Tech Books, New Delhi.
Premjit Sharma (Ed.). 2008. *Seed Legislation*. Gene-Tech Books, New Delhi.

SST 515 EMERGING TRENDS IN SEED QUALITY ENHANCEMENT 1+1 SEM - I

Objective

To update knowledge on seed quality enhancement technologies and their application.

Theory

UNIT-I: Concept and significance of seed quality enhancement; physical, chemical and pesticidal seed treatments, history, principles and methods of seed treatment, methodology and factors affecting seed enhancement treatments.

UNIT-II: Seed priming: physiological and biochemical basis, types of priming technology, biochemical and molecular changes associated, pregermiantion, film coating and pelleting, seed tapes, seed mats, seed colouring, biopriming.

UNIT-III: Synthetic seeds ï Aim and scope for synthetic seeds, historical development, somatic embryogenesis, somaclonal variation and their control, embryo encapsulation systems, hardening of artificial seeds, cryo-preservation, storage of artificial seeds, desiccation tolerance, use of botanicals in improving seed quality etc.

Practical

Seed treatments ï methods and techniques, equipments required for seed treatment, film coating; seed invigoration/priming - hydration and dehydration, PEG priming, solid matrix priming, bio priming, effects of priming; methods for hydrogel encapsulation of artificial endosperm, hydrophobic coating etc.; protocols for production of synthetic seeds, Visit to leading Seed Companies to study the seed treatment processes.

Suggested Readings

Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implication*s. Food Product Press, NY.
Basra AS. 2006. *Handbook of Seed Science and Technolog*y. Food Product. Press, NY.
Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiolog*y. Food Product Press, NY/ London.
Copland LO & McDonald MB. 2004. *Seed Science and Technolog*y. Kluwer Acad.
Kalloo G, Jain SK, Vari AK & Srivastava U. 2006. *Seed: A Global Perspectiv*e. Associated Publ.

SST 516/ GP 517 DATABASE MANAGEMENT, EVALUATION AND UTILIZATION OF PGR 2+1 SEM - II

Objective

To train the students in germplasm data base management using modern tools and softwares.

Theory

UNIT-I: Statistical techniques in management of germplasm, core identification, estimation of sample size during plant explorations, impact of sampling on population structure; sequential sampling for viability estimation, introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and nomograms, estimation of sample size for storage and viability testing.

UNIT-II: Germplasm documentation; basics of computer and operating systems, database management system, use of statistical softwares, pictorial and graphical representation of data; introduction to communication network.

UNIT-III: Germplasm management system: global scenario, genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections; necessity of germplasm evaluation; predictive methods for identification of useful germplasm;characterization of germplasm and evaluation procedures including specific traits, Gene markers and their use in PGR management, germplasm enhancement, prebreeding and utilizing wild species in crop improvement.

UNIT-IV: Management and utilization of germplasm collections; concept of core collection, molecular markers and their use in characterization, evaluation and utilization of genetic resources; pre-breeding/ genetic enhancement, utilizing wild species for crop

improvement; harmonizing agro-biodiversity and agricultural development crop diversification; participatory plant breeding.

Practical

Basics of computer and operating systems- identification of useful germplasm; evaluation of crop germplasm, Statistical techniques in management of germplasm- estimation of sample size for storage and viability testing. Evaluation procedure and experimental protocols (designs and their analysis), Assessment of genetic diversity; Techniques of Characterization of germplasm, Molecular markers and their use in characterization.

Suggested Readings

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.

Puzone L & Th. Hazekamp 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

SST 601 HYBRID SEED PRODUCTION 1+ 1 SEM - II

Objective

To provide a comprehensive knowledge and practical exposure to hybrid seed production in field crops and vegetables.

Theory

UNIT-I: Heterosis: definition, expression and estimation of hybrid vigour; utilization of heterosis in agricultural, horticultural and other crop plants for crop improvement.

UNIT-II: Pre-requisites for hybrid seed production; mechanisms and management of pollination in autogamous and allogamous crops; genetic constitution of varieties, hybrids and basic principles in seed production.

UNIT-III: Techniques of hybrid seed production - emasculation and crossing: use of self-incompatibility, modification of sex; types of male sterility and exploitation in hybrid development and its use in hybrid seed production; development and maintenance of A, B and R lines.

UNIT-IV: Fertility restoration; use of chemical hybridizing agents, problems of non synchrony in flowering of parental lines and methods to overcome; planting ratios and population density in relation to hybrid seed yield; salient features of hybrid seed production of various crops viz., rice, sorghum, bajra, maize, sunflower, cotton and other major vegetables.

Practical

Methods of hybrid seed production in major agricultural and horticultural crops; planting of rows/blocks of parental lines and manipulations for achieving flowering synchrony for production of hybrid seeds, maintenance of A, B and R lines and production of breeder seed; stable diagnostic characteristics of parental lines and their hybrids; genetic purity tests; determination of cost of hybrid seed production of various crops; visit to seed production plots etc.

Suggested Readings

Basra AS. 2000. *Heterosis and Hybrid Seed Production in Agricultural Crop*s. Food Product Press.

McDonald MB & Copeland LO. 1997. *Seed Production: Principles and Practice*s. Chapman & Hall.

Singhal NC. 2003. *Hybrid Seed Productio*n. Kalyani Publishers.

SST 602/ GP 610 *IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM 2+1 SEM - II

(To be taught by Genetics and Plant Breeding)

Objective

To impart knowledge on the methods of germplasm conservation.

Theory

UNIT-I: Concept of natural reserves and natural gene banks, *In situ* conservation of wild species in natural reserves: *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation; *in situ* conservation of agro-biodiversity on-farm; scientific basis of *in situ* conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of *in situ*

conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT-II: *Ex situ* conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, *perma-frost* conservation, guidelines for sending seeds to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling ,clonal repositories, genetic stability under long term storage condition.

UNIT-III: *In vitro* storage, maintenance of *in vitro* culture under different conditions, *in vitro* bank maintenance for temporate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems , prospects of *in vitro* gene bank.

UNIT-IV: Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants,dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture, horticulture and forestry crops.Problems and prospects; challenges aheads.

Practical

In situ conservation of wild species ï case studies at national and international levels- *ex situ* techniques for active and long-term conservation of collections- Preparation and handling of materials, packaging, documentation; design of cold storage modules-Conservation protocols for recalcitrant and orthodox seeds; Cytological studies for assessing genetic stability, *in vitro* cultures- embryo,cell/suspension cultures,pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR - study using fruit crops and other horticultural crops.

Suggested Readings

Ellis RH & Roberts EH & White Head J. 198*0. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Bank*s. FAO / IBPGR Pl. Genet. Resources News 41-3-18.

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorro*w. Cambridge University Press, Cambridge.

Simmonds, N.W. 1979. *Principles of Crop Improvement* Longman.

Westwood MN. 1986. *Operation Manual for National Clonal Germplasm Repository Processed Repor*t. USDA-ARS and Orgon State Univ. Oregon, USA.

Withers LA. 1980. *Tissue Culture Storage for Genetic Conservatio*n. IBPGR Tech. Rep. IBPGR, Rome, Italy.

SST 603 TESTING FOR GENUINENESS AND PURITY OF CULTIVARS 1+1 SEM - I

Objective

To provide hands-on training on various field and laboratory methods of testing cultivar purity.

Theory

UNIT-I: Objective of cultivar purity test, general principles and methods involved. Use and limitations of laboratory, green house and field plot methods in determination of genuineness of cultivars; a case study in hybrid cotton, reporting of results and inference.

UNIT-II: Chemical-biochemical tests for species and cultivar purity: phenol test, seed and seedling tests, electrophoretic analysis of seed protein, isozymes etc, use of chromatography for analysis of secondary compounds etc.

UNIT-III: DNA finger printing (RAPD, SSR, AFLP etc) and their use in varietal purity testing and registration of new varieties.

UNIT-IV: Use of computer-based machine vision (MVT) for varietal identification and purity testing.

Practical

Chemical and biochemical tests for species and cultivar purity: phenol test, seed and seedling tests, electrophoretic analysis of seed protein and isozymes, DNA fingerprinting using PCR techniques, use of chromatography for analysis of secondary compounds.

Suggested Readings

Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implication*s. Food Product Press.

ISTA 2006. *Handbook of Variety Testin*g. International Seed Testing Association, Switzerland.

SST 604 DUS TESTING FOR PLANT VARIETY PROTECTION 2+1 SEM - I

Objective

To provide a comprehensive understanding of DUS testing, its conduct and significance to PVP.

Theory

UNIT-I: Genesis of plant variety protection (PVP); International Union for Protection of New Varieties of Plants (UPOV) and its functions; General agreements on Tariff and Trades (GATT) agreement in relation to protection of plant varieties; Protection of Plant Varieties and Farmers' Rights (PPV &FR) Act, 2001; PPV&FR rules, 2003.

UNIT-II: Criteria for protection of new varieties of plants; principles and procedures of Distinctness, Uniformity and Stability (DUS) testing; test guidelines, planting material, duration, testing options, varieties of common knowledge, reference collection, grouping of varieties, types and categories of characters; technical questionnaire.

UNIT-III: Assessment of DUS characters based on morphological, biochemical and molecular markers; statistical procedures; computer software for use in DUS testing; impact of PVP on growth of seed industry; practical exercise of DUS testing in rice, wheat, pearl- millet, maize, rose and cauliflower.

Practical

Morphological description of plant parts and plant; character expression and states, recording observation and interpretation of data; chemical tests and markers applicable for DUS tests and case study of selected crops.

Suggested Readings

Chakrabarty SK, Prakash S, Sharma SP & Dadlani M. 2007. *Testing Of Distinctiveness, Uniformity And Stability For Plant Variety Protectio*n. IARI, New Delhi.

Joshi AK & Singh BD. 2004. *Seed Science And Technolog*y. Kalyani.

The Protection Of Plant Varieties And Farmersô Rights Act 2001. Bare Act With Short Notes 2006. Universal Law Publ.

SST 605 ADVANCES IN SEED SCIENCE RESEARCH 1+0 SEM - II

Objective

To provide knowledge on the advances in various aspects of seed science & their application in seed technology.

Theory

UNIT-I: Physiological and molecular aspects of seed development and control of germination and dormancy; gene expression during seed development; desiccation and stress tolerance and conservation; prediction of seed dormancy and longevity using mathematical models; structural changes in membranes of developing seeds during acquisition of desiccation tolerance; dehydration damage and repair in imbibed seeds, seed biotechnology; genetic analysis and QTL mapping of germination traits; seed ageing and ethylene production; recent accomplishments in seed enhancement research and application of nanotechnology.

UNIT-II: Modern techniques for identification of varieties and hybrids; principles and procedures of electrophoresis, machine vision technique, DNA fingerprinting and other molecular techniques and their utilization; techniques for improving seed quality; proteomic analysis; seed priming, coating, pelleting and synthetic seeds; GM seeds and their detection, terminator technology (GURT).

UNIT-III: Detection and identification of seed borne fungi, bacteria, viruses,nematodes and insect pests through advanced techniques like ELISA, PCR based techniques etc.

UNIT-IV: Seed production of self incompatible and apomictic plant species; recent developments in seed laws, policies and seed certification system in India and its comparison with OECD seed certification schemes; IPR systems and PVP internationally.

Suggested Readings

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiolog*y. Food Product Press.

Black M & Bewley JD. (Eds.). 2000. *Seed Technology and its Biological Basi*s. Sheffield Academic Press.

Nicolas G, Bradford KJ, Come D & Pritchard HW. 2003. *The Biology of Seeds, Recent Research Advance*s. CABI.

SEED SCIENCE AND TECHNOLOGY

List of Journals

- Acta Hoticulturae
- Crop Science
- Hort. Science
- Indian Journal of Agricultural Science.
- ISST News Bulletin
- Journal of Seed Production
- Journal of Seed Technology
- New Seed Journal
- Plant Varieties and Seeds
- Seed Abstracts
- Seed Research
- Seed Science & Technology
- Seed Science Research

e-Resources

- Ag Biotech Reporter www.bioreporter.com
- Agricultural Research Magazine *www.ars.usda.gov/is/AR/*
- American Seed Trade Association www.amseed.com
- Association of Official Seed Certifying Agencies www.AOSCA.org
- Association of Official Seed Analysts www.aosaseed.com
- Commercial Seed Analysts Association of Canada www.seedanalysts.com
- Front Range Seed Analysts www.frsa.org
- International Seed Federation www.wordseed.org
- International Seed Testing Association www.seedtest.org
- International Society for Seed Science www.css.comell.edu/ISSS/isss.htm
- International Society of Seed Technologists www.isstech.org
- The Seed Biology web page at Cornell University
- www.css.comelI.edu/seedbio/seedbio.html
- Seed Biology at the Laboratory of Plant Physiology at the Wageningen University
- www.wau.nl/uk/organisation
- The Ohio State Seed Biology webpage www.css.ohio-state.edu/%7Eseebio/
- The Seed Biotechnology Center University of California http://sbc.ucdavis.edul
- Seed Viability and Storage Research Unit www.ars-grain.
- gov/ars/NoPlains/FtCollins/preservation.htm
- Seed World www.seedworld.com
- Seed Quest www.seedquest.com
- Seed Today www.seedtoday.com/info/ST sites.html
- The South African National Seed Organization www.sansor.org/index.htm
- Society of Commercial Seed Technologists www.seedtechnology.net
- Wageningen Seed Centre www.seedcentre.nl

Suggested Broad Areas for Master's and Doctoral Research

- Isolation distance requirements in view of GM varieties
- Review of seed certification standards
- GOT ï seasonal requirements
- Genetic purity vis-a-vis trait purity
- Enhancement of pollen viability, stigma receptivity and seed setting
- Reduction of processing losses
- Alternate areas / protected cultivation methods for hybrid seed production
- Standardising processing needs in high value crops and forage grasses

- Protein and oil content in GM cotton seed and its effect on longevity
- Optimisation of hybrid seed production technology in field crops, vegetables and flowers
- Pollen collection methods and viability testing
- Management of seed borne diseases with biocontrol agents
- Seed enhancement for unfavorable conditions
- Identification of markers for hybrid confirmation and genetic purity testing
- GM seed testing
- Seed testing protocols and seed standards for forage crops, medicinal species and spices
- Molecular control of seed viability, vigour and invigoration
- Standardisation of priming, coating and pelleting technologies
- Development of technologies for maintenance of parental lines of SI and MS based hybrids
- Any other location specific problems

SOILS SCIENCE

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
SOILS 501*	SOIL PHYSICS	2+1	II
SOILS 502*	SOIL FERTILITY AND FERTILIZER USE	3+1	I
SOILS 503*	SOIL CHEMISTRY	2+1	I
SOILS 504*	SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY	2+1	II
SOILS 505	SOIL EROSION AND CONSERVATION	2+1	II
SOILS 506*/ ❶ MICRO 504	SOIL MICROBIOLOGY	2+1	I
SOILS 507	GEOMORPHOLOGY AND GEOCHEMISTRY	2+0	II
SOILS 508	RADIOISOTOPES IN SOIL AND PLANT STUDIES	1+1	II
SOILS 509	SOIL, WATER AND AIR POLLUTION	2+1	II
SOILS 510	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES	2+1	I
SOILS 511	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	0+2	I
SOILS 512	SYSTEM APPROACHES IN SOIL AND CROP STUDIES	2+1	II
SOILS 513	MANAGEMENT OF PROBLEMATIC SOILS AND WATERS	2+1	II
SOILS 514	FERTILIZER TECHNOLOGY	1+0	II
SOILS 515	LAND DEGRADATION AND RESTORATION	1+0	II
SOILS 591	MASTERôS SEMINAR	1	I, II
SOILS 599	MASTERôS RESEARCH	20	I, II
SOILS 601**	ADVANCES IN SOIL PHYSICS	3+0	II
SOILS 602**	ADVANCES IN SOIL FERTILITY	3+0	II
SOILS 603**	PHYSICAL CHEMISTRY OF SOILS	2+0	II
SOILS 604**	SOIL GENESIS AND MICROPEDOLOGY	2+0	I
SOILS 605**	BIOCHEMISTRY OF SOIL ORGANIC MATTER	2+0	I
SOILS 606	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0	I
SOILS 691	DOCTORAL SEMINAR I	1	I, II
SOILS 692	DOCTORAL SEMINAR II	1	I, II
SOILS 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSE			
ABM 519	FERTILIZER TECHNOLOGY AND MANAGEMENT	2+0	

*Compulsory for Masterôs programme; **Compulsory for Doctoral programme

❶ To be taught jointly by Soil Science and Microbiology

SOIL SCIENCE

Course Contents

SOILS 501 SOIL PHYSICS 2+1 SEM - II

Objective

To impart basic knowledge about soil physical properties and processes in relation to plant growth.

Theory

UNIT-I: Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT-II: Soil texture, textural classes, mechanical analysis, specific surface.

UNIT-III: Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

UNIT-IV: Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

UNIT-V: Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

UNIT-VI: Water flow in saturated and unsaturated soils, Poiseuilleôs law, Darcyôs law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.

UNIT-VII: Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

UNIT-IX: Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

UNIT X: Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

- Mechanical analysis by pipette and international methods
- Measurement of Atterberg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods
- Measurement of soil-water potential by using tensiometer and gypsum blocks
- Determination of soil-moisture characteristics curve and computation of pore-size distribution
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.

Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.

Hillel D. 1980. *Applications of Soil Physics*. Academic Press.

Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.

Hillel D. 1998. *Environmental Soil Physi*cs. Academic Press.

Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.

Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.

Kohnke H. 1968. *Soil Physics*. McGraw Hill.

Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SOILS 502 SOIL FERTILITY AND FERTILIZER USE 3+1 SEM - I

Objective

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

UNIT-I: Soil fertility and soil productivity; nutrient sources ï fertilizers and manures; essential plant nutrients - functions and deficiency symptoms.

UNIT-II: Soil and fertilizer nitrogen ï sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

UNIT-III: Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT-IV: Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT-V: Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesiumï factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT-VI: Micronutrients ï critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

UNIT-VII: Common soil test methods for fertilizer recommendations; quantityï intensity relationships; soil test crop response correlations and response functions.

UNIT-VIII: Fertilizer use efficiency; blanket fertilizer recommendations ï usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.

UNIT-IX: Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical

- Principles of colorimetry
- Flame-photometry and atomic absorption spectroscopy
- Chemical analysis of soil for total and available nutrients
- Analysis of plants for essential elements

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.

Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.

Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.

Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality.* 2nd Ed. CRC Press.

Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen,Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.

Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

SOILS 503 SOIL CHEMISTRY 2+1 SEM - I

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

Theory

UNIT-I: Chemical (elemental) composition of the earthôs crust and soils.

UNIT-II: Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT-III: Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

UNIT-IV: Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jennyôs concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange ï innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

UNIT-V: Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT-VI: Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT-VII: Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments.

UNIT-VIII: Chemistry and electrochemistry of submerged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Ä (E4/E6) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by BaCl2-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford & IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SOILS 504 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY 2+1 SEM - II

Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

UNIT-I: Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

UNIT-II: Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils.

UNIT-III: Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT-IV: Concept of soil individual; soil classification systems ï historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps ï usefulness.

UNIT-V: Soil survey and its types; soil survey techniques - conventional and modern; soil series ï characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT-VI: Landform ï soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) ï concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy.* McGraw Hill.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi

Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.

USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.

Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.

Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

SOILS 505 SOIL EROSION AND CONSERVATION 2+1 SEM - II

Objective

To enable students to understand various types of soil erosion and measures to be taken for controlling soil erosion to conserve soil and water.

Theory

UNIT-I: History, distribution, identification and description of soil erosion problems in India.

UNIT-II: Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT-III: Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT-IV: Principles of erosion control; erosion control measures ï agronomical and engineering; erosion control structures - their design and layout.

UNIT-V: Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT-VI: Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

- Å Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index
- Å Computation of kinetic energy of falling rain drops
- Å Computation of rainfall erosivity index (EI30) using rain gauge data
- Å Visits to a watersheds

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.

Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

SOILS 506/ MICRO 504 **SOIL MICROBIOLOGY** **2+1** **SEM - I**

(To be taught jointly by Soil Science and Microiology)

Objective

To teach students regarding basics of microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

UNIT-I: Soil biota, Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota.

UNIT-II: Microbiology and biochemistry of root - soil interface; phyllosphere, Biofertilizers, soil enzyme activities and importance.

UNIT-III: Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biochemical composition and biodegradation of soil organic matter and crop residues.

UNIT-IV: Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development.

Practical

Determination of soil microbial population; Soil microbial biomass; Decomposition studies in soil, Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification. N_2 fixation, S oxidation, P solubilization and mineralization of other micro-nutrients; Study of rhizosphere effect.

Suggested Readings

Martin Alexander 1977. *Soil Microbiology*. John Wiley.

Paul EA. 2007. *Soil Microbiology, Ecology and Biochemistry*. 3rd ed. Academic Press.

Sylvia *et al.* 2005. *Principles and Applications of Soil Microbiology*. 2nd ed. Pearson Edu.
Van Elsas JD, Trevors JT & Wellington EMH. 1997. *Modern Soil Microbiology*. Marcel Dekker.

SOILS 507 GEOMORPHOLOGY AND GEOCHEMISTRY 2+0 SEM - II

Objective

To impart knowledge about the landforms, physiography and morphology of the earth surface, and distribution and weathering elements in the earth crust.

Theory

UNIT-I: General introduction to geology and geochemistry, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.

UNIT-II: Methodology of geomorphology, its agencies, erosion and weathering; soil and physiography relationships; erosion surface of soil landscape.

UNIT-III: Geochemical classification of elements; geo-chemical aspects of weathering and migration of elements; geochemistry of major and micronutrients and trace elements.

Suggested Readings

Brikland PW. 1999. *Soils and Geomorophology*. 3rd Ed. Oxford Univ. Press.
Likens GE & Bormann FH. 1995. *Geochemistry*. 2nd Ed. Springer Verlag.
Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

SOILS 508 RADIOISOTOPES IN SOIL AND PLANT STUDIES 1+1 SEM - II

Objective

To train students in the use of radioisotopes in soil and plant research.

Theory

UNIT-I: Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter.

UNIT-II: Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography.

UNIT-III: Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency; carbon dating.

UNIT-IV: Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive wastes.

Practical

- Storage and handling of radioactive materials
- Determination of half life and decay constant
- Preparation of soil and plant samples for radioactive measurements
- Setting up of experiment on fertilizer use efficiency and cation exchange equilibria using radioisotopes
- Determination of A, E and L values of soil using 32P/ 65Zn
- Use of neutron probe for moisture determination
- Sample preparation and measurement of 15N enrichment by mass spectrophotometery/ emission spectrometry

Suggested Readings

Comer CL. 1955. *Radioisotopes in Biology and Agriculture: Principles and Practice*. Tata McGraw Hill.
Glasstone S. 1967. *Source Book on Atomic Energy*. East West Press.
Michael FL & Annunziata. 2003. *Handbook of Radioactivity Analysis*. Academic Press.

SOILS 509 SOIL, WATER AND AIR POLLUTION 2+1 SEM - II

Objective

To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.

Theory

UNIT-I: Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT-II: Nature and sources of pollutants ï agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT-III: Sewage and industrial effluents ï their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT-IV: Pesticides ï their classification, behavior in soil and effect on soil microorganisms.

UNIT-V: Toxic elements ï their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT-VI: Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases ï carbon dioxide, methane and nitrous oxide.

UNIT-VIII: Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical

- Å Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants
- Å Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents
- Å Heavy metals in contaminated soils and plants
- Å Management of contaminants in soil and plants to safeguard food safety
- Å Air sampling and determination of particulate matter and oxides of sulphur
- Å Visit to various industrial sites to study the impact of pollutants on soil and Plants

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect.* CRC Press.

Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience.

Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.

Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.

SOILS 510 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES 2+1 SEM - I

Objective

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to krigging, and GIS and applications in agriculture.

Theory

UNIT-I: Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT-II: Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations.

UNIT-III: Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.

UNIT-IV: Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

UNIT-V: Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

Practical

- Å Familiarization with different remote sensing equipments and data products
- Å Interpretation of aerial photographs and satellite data for mapping of land resources

- Å Analysis of variability of different soil properties with classical and geostatistical techniques
- Å Creation of data files in a database programme
- Å Use of GIS for soil spatial simulation and analysis
- Å To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.

Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.

Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.

Star J & Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

SOILS 511 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS **0+2** **SEM - I**

Objective

To familiarize the students with commonly used instruments ï their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT-I: Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidationreduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT-II: Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT-III: Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

UNIT-IV: Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT-V: Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

UNIT-VI: Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.

UNIT-VII: Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.

Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.

Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.

Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.

Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.

Piper CE. *Soil and Plant Analysis*. Hans Publ.

Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*. IARI, New Delhi.

Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.

Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.

Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

SOILS 512 SYSTEM APPROACHES IN SOIL AND CROP STUDIES 2+1 SEM - II

Objective

To train the students in concepts, methodology, technology and use of systems simulation in soil and crops studies.

Theory

UNIT-I: Systems concepts - definitions, general characteristics; general systems theory; systems thinking, systems dynamics, systems behavior and systems study.

UNIT-II: Model: definition and types; mathematical models and their types; modeling: concepts, objectives, processes, abstraction techniques; simulation models, their verification and validation, calibration; representation of continuous systems simulation models - procedural and declarative.

UNIT-III: Simulation - meaning and threats; simulation experiment, its design and analysis.

UNIT-IV: Application of simulation models in understanding system behavior, optimizing system performance, evaluation of policy options under different soil, water, nutrient, climatic and cultural conditions; decision support system, use of simulation models in decision support system.

Practical

- Use of flow chart or pseudo-code in the program writing
- Writing a small example simulation model program - declarative (in Vensim PLE, Stella or Simile) and procedural (in Java, Fortran, QBasic or V Basic)
- Conducting simulation experiments in DSSAT, WOFOST or EPIC with requirement of report and conclusion

Suggested Readings

Benbi DK & Nieder R. (Eds.). 2003. *Handbook of Processes and Modelling in the Soil - Plant System*. Haworth Press.

Hanks J & Ritchie JT. (Eds.). 1991. *Modelling Plant and Soil System. Agronomy***.** Bull. No 31. Soil Sci. Society of America, Madison.

Rajaraman V. 2004. *Computer Programming in Fortran 90 and 95*. PHI.

Tsuji GY, Gerrit H & Philip T. 1998. *Understanding Options for Agricultural Production.* Kluwer.

von Bertalanffy Ludwig 1969. *General Systems Theory: Foundation Development and Application*. Revised Ed. George Braziller Reprint 1998.

Websites

- Documentation of the respective models. (http://www.simulistics.com/for Simile; http://www.iseesystems.com for Stella; and http://www.vensim.com/software.html for vensim PLE)
- http://www.icasa.net/dssat/index.html for DSSAT; http://www.brc.tamus.edu/epic/ for EPIC
- http://www.nrel.colostate.edu/projects/century/ for Century
- http://www.alterra.wur.nl/NL/for WOFOST
- http://www.apsru.gov.au/ apsru/Default.htm for APSIM
- http://eco.wiz.uni-kassel.de/ecobas.html online Register of ecological models
- Plentinger MC Penning de Vries FWT, Editors (1996) CAMASE Register of Agro-ecosystems Models. DLO-Research Institute for Agrobiology and Soil Fertility (AB-DLO)
- Agricultural Systems ï Elsevier at http://www.elsevier.com/wps/product/cws_home /405851
- Ecological Modeling ï Elsevier at http://www.elsevier.com/locate/ecolmodel

SOILS 513 MANAGEMENT OF PROBLEM SOILS AND WATERS 2+1 SEM - II

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

UNIT-I: Area and distribution of problem soils ï acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible**.**

UNIT-II: Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.

UNIT-III: Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.

UNIT-IV: Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.

UNIT-V: Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.

UNIT-VI: Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

- Å Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Å Determination of cations (Na+, K+, Ca++ and Mg++) in ground water and soil samples
- Å Determination of anions (Cl-, SO4 --, CO3 -- and HCO3 -) in ground waters and soil samples
- Å Lime and gypsum requirements of acid and sodic soils

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

SOILS 514 FERTILIZER TECHNOLOGY 1+0 SEM - II

Objective

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

Theory

UNIT-I: Fertilizers ï production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order.

UNIT-II: Manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents.

UNIT-III Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

UNIT-IV: New and emerging issues in fertilizer technology ï production and use of slow and controlled release fertilizers, supergranules fertilizers and fertilizers for specific crops/situations.

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.

Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI New Delhi.

Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.

Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technology and Use.* 2nd Ed. Soil Sci. Soc. Am. Madison.

Prasad R & Power JF. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* McMillan Publ.

Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.

SOILS 515 LAND DEGRADATION AND RESTORATION 1+0 SEM - II

Objective

To impart knowledge related to various factors and processes of land degradation and their restoration techniques.

Theory

UNIT-I: Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment.

UNIT-II: Land restoration and conservation techniques - erosion control, reclamation of salt-affected soils; mine land reclamation, afforestation, organic products.

UNIT-III: Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.). 1996. *Soil Management in Relation to Land Degradation and Environment. Bull. Indian Soc. Soil Sci.* 17, New Delhi.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Madison.

Greenland DJ & Szabolcs I. 1994. *Soil Resilience and Sustainable Land Use*. CABI.

Lal R, Blum WEH, Vailentine C & Stewart BA. 1997. *Methods for Assessment of Soil Degradation.* CRC Press.

Sehgal J & Abrol IP. 1994. *Soil Degradation in India - Status and Impact*. Oxford & IBH.

SOILS 601 ADVANCES IN SOIL PHYSICS 3+0 SEM - II

Objective

To provide knowledge of modern concepts in soil physics.

Theory

UNIT-I: Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

UNIT-II: Fundamentals of fluid flow, Poiseuilles law, Laplaceôs equation, Darcyôs law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcyôs law; numerical solution for one dimensional water flow.

UNIT-III: Theories of horizontal and vertical infiltration under different boundary conditions.

UNIT-IV: Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

UNIT-V: Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

UNIT-VI: Soil crust and clod formation; structural management of puddled rice soils; soil conditioning- concept, soils conditioners - types, characteristics, working principles, significance in agriculture.

UNIT-VII: Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Hanks and Ascheroft. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1980. *Applications of Soil Physics*. Academic Press.

Hillel D. 1980. *Environmental Soil Physi*cs. Academic Press.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley Interscience.

Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.

Oswal MC.1994. *Soil Physics*. Oxford & IBH.

SOILS 602 ADVANCES IN SOIL FERTILITY 3+0 SEM - II

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT-I: Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

UNIT-II: Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT-III: Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.

UNIT-IV: Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT-V: Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT-VI: Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Suggested Readings

Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.

Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*. CRC / Taylor & Francis.

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Educ.

Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood & Sons.

Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*. International Potash Institute, Switzerland.

Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC / Taylor & Francis.

Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technolo*gy. Scientific Publ.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture.* 2nd Ed. Soil Science Society of America, Madison.

Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen Phosphorus, Sulphur, Micronutrients.* John Wiley & Sons.

Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers.* 5th Ed. Macmillan Publ.

Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

SOILS 603 PHYSICAL CHEMISTRY OF SOILS 2+0 SEM - II

Objective

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

Theory

UNIT-I: Colloidal chemistry of inorganic and organic components of soils ï their formation, clay organic interaction.

UNIT-II: Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients; structure and properties of diffuse double layer.

UNIT-III: Thermodynamics of nutrient transformations in soils; cationic and anionic exchange and their models, molecular interaction.

UNIT-IV: Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

UNIT-V: Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford & IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Fried M & Broeshart H. 1967. *Soil Plant System in Relation to Inorganic Nutrition.* Academic Press.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. 1978. *Chemistry of Soil Constituents*. John Wiley & Sons.

Jurinak JJ. 1978. *Chemistry of Aquatic Systems*. Dept. of Soil Science & Biometeorology, Utah State Univ.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sparks DL. 1999. *Soil Physical Chemistry*. 2nd Ed. CRC Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils.* Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley.

van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SOILS 604 SOIL GENESIS AND MICROPEDOLOGY 2+0 SEM - I

Objective

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

Theory

UNIT-I: Pedogenic evolution of soils; soil composition and characterization.

UNIT-II: Weathering and soil formation ï factors and pedogenic processes; stability and weathering sequences of minerals.

UNIT-III: Assessment of soil profile development by mineralogical and chemical analysis.

UNIT-IV: Micro-pedological features of soils ï their structure, fabric analysis, role in genesis and classification.

Suggested Readings

Boul SW, Hole ED, MacCraken RJ & Southard RJ. 1997. *Soil Genesis and Classification.* 4th Ed. Panima Publ.

Brewer R. 1976. *Fabric and Mineral Analysis of Soils.* John Wiley & Sons.

SOILS 605 BIOCHEMISTRY OF SOIL ORGANIC MATTER 2+0 SEM - I

Objective

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Theory

UNIT-I: Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.

UNIT-II: Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

UNIT-III: Nutrient transformation ï N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.

UNIT-IV: Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes.

UNIT-V: Humus - pesticide interactions in soil, mechanisms.

Suggested Readings

Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. Organic *Substances in Soil and Water: Natural Constituents and their Influences on Contaminant Behavior*. Royal Society of Chemistry, London.

Gieseking JE. 1975. *Soil Components*. Vol. 1. *Organic Components*. Springer-Verlag.

Kristiansen P, Taji A & Reganold J. 2006. *Organic Agriculture: A GlobalPerspective.* CSIRO Publ.

Magdoff F & Weil RR 2004. *Soil Organic Matter in SustainableAgriculture*. CRC Press.

Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics andSustainability of Tropical Agriculture.* John Wiley & Sons.

Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.

Stevenson FJ. 1994. *Humus Chemistry – Genesis, Composition and Reactions.* John Wiley & Sons.

SOILS 606 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0 SEM - I

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

Theory

UNIT-I: Concept and techniques of land use planning; factors governing present land use.

UNIT-II: Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT-III: Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production.

UNIT-IV: Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT-V: Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

Suggested Readings

All India Soil and Land Use Survey Organisation 1970. *Soil Survey Manual*. IARI, New Delhi.

FAO. 1976. *A Framework for Land Evaluation*, Handbook 32. FAO.

Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-EcologicalRegions of India*. NBSS & LUP, Nagpur.

Soil Survey Staff 1998. *Keys to Soil Taxonomy*. 8th Ed. USDA & NRCS, Washington, DC.

USDA 1974. *A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers*. Oxford & IBH.

SOIL SCIENCE

List of Journals

- Advances in Agronomy
- Annals of Arid Zone
- Australian Journal of Agricultural Research
- Australian Journal of Soil Research
- Biology and Fertility of Soils
- Communications in Soil Science and Plant Analysis
- Clays and Clay minerals
- European Journal of Soil Science
- Geoderma
- Indian Journal of Agricultural Sciences
- Journal of Plant Nutrition and Soil Science
- Journal of the Indian Society of Soil Science
- Nutrient Cycling in Agroecosystems
- Plant and Soil
- Soil and Tillage Research
- Soil Biology and Biochemistry
- Soil Science
- Soil Science Society of America Journal
- Soil Use and Management
- Water, Air and Soil Pollution
- Water Resources Research

Suggested Broad Topics for Master's and Doctoral Research

- Degradation and restoration of soil as natural resource
- Biochemistry of processes at the soil-root interface
- Impact of current agricultural practices and agrochemicals on soil quality/biodiversity
- Integrated nutrient management for sustainable agriculture
- Fertilizer use efficiency in different soil conditions/cropping systems
- Use of remote sensing and GIS as diagnostic tool for natural resource management
- Role of biological agents in soil productivity
- Modeling solute (salt, fertilizer, pesticides) transport in soil
- Use of poor quality waters in Agriculture
- Soil testing and crop response
- Site-specific nutrient management and precision agriculture
- Nutrient dynamics in soil-plant system and modeling nutrient uptake
- Tillage and crop residue management in crop production
- Utilization of urban and industrial wastes/effluents in Agriculture
- Management of problematic soils
- Impact of climate change on soil processes
- Micronutrients in soil, plant and human health
- Water management strategies in different cropping systems
- Simulation models for growth and production of different crops
- Varietals response to soil salinity/ sodicity/ nutrients/ pollutants, etc
- Soil and water pollution - monitoring and control
- Genesis, formation and classification of soils
- Soil conservation, preservation and management for sustainable agriculture
- Remediation of polluted and contaminated soils

VEGETABLE SCIENCE

Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
VSC 501*	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	2+1	I
VSC 502*	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	2+1	II
VSC 503*	BREEDING OF VEGETABLE CROPS	2+1	I
VSC 504*	GROWTH AND DEVELOPMENT OF VEGETABLE CROPS	2+1	I
VSC 505/ ❶ SST 504	SEED PRODUCTION IN VEGETABLES	2+1	II
VSC 506	SYSTEMATICS OF VEGETABLE CROPS	1+1	I
VSC 507	PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS	2+1	I
VSC 508	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	1+1	II
VSC 509	FUNDAMENTALS OF PROCESSING OF VEGETABLES	2+1	II
VSC 510/ ❶ PSMA 502	PRODUCTION TECHNOLOGY OF SPICE CROPS	2+1	II
VSC 511	POST HARVEST TECHNOLOGY OF VEGETABLE CROPS	2+1	II
VSC 591	MASTERôS SEMINAR	1	I, II
VSC 599	MASTERôS RESEARCH	20	I, II
VSC 601**	ADVANCES IN VEGETABLE PRODUCTION	2+1	I
VSC 602**	ADVANCES IN BREEDING OF VEGETABLE CROPS	2+1	II
VSC 603**	PROTECTED CULTIVATION OF VEGETABLE CROPS	1+1	I
VSC 604**/ ❷ MBB 604/ FLA 605	ADVANCES IN CROP BIOTECHNOLOGY	3+0	I
VSC 605	ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS	2+1	II
VSC 691	DOCTORAL SEMINAR-I	1+0	I, II
VSC 692	DOCTORAL SEMINAR-II	1+0	I, II
VSC 699	DOCTORAL RESEARCH	45	I, II
SERVICE COURSES			
PSMA 504	BREEDING OF PLANTATION CROPS AND SPICES	2+1	I
PSMA 507	ORGANIC SPICE AND PLANTATION CROP PRODUCTION TECHNOLOGY	2+1	II
PSMA 602	ADVANCES IN SPICE PRODUCTION	2+1	I
PSMA 604	ADVANCES IN BREEDING OF PLANTATION CROPS AND SPICES	2+1	I

* Compulsory for Masterôs programme; **Compulsory for Doctoral programme
One course of Genetics & Plant Breeding of 3 credits is compulsory as Minor/Supporting

To be taught by: ❶ Vegetable Science; ❷ Molecular Biology & Biotechnology

VEGETABLE SCIENCE

Course Contents

VSC 501 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 2+1 SEM - I

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 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.

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.

Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.

Bose TK, Som MG & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* Vols. V-X. Malhotra Publ. House.

Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.

Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.

Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.

Edmond JB, Musser AM & Andrews FS. 1951. *Fundamentals of Horticulture*. Blakiston Co.

Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.

Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.

Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.

Rana MK. 2008. *Olericulture in India*. Kalyani Publ.

Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.

Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.

Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.

Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.

Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.

Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.

Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw-Hill.

VSC 502 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 2+1 SEM - II

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 cluster bean.

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.

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.

Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.

Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. V-X. Malhotra Publ. House.

Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.

Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.

Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.

Edmond JB, Musser AM & Andrews FS. 1964. *Fundamentals of Horticulture*. Blakiston Co.

Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.

Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.

Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.

Kalloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ.

Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency.

Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques.*

Rana MK. 2008. *Olericulture in India*. Kalyani.

Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.

Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.

Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.

Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.

Singh NP, Bharadwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distributing Co.

Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

VSC 503 BREEDING OF VEGETABLE CROPS 2+1 SEM - I

Objective

To educate principles and practices adopted for breeding of vegetable crops.

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act.

UNIT-I: Potato and tomato.

UNIT-II: Eggplant, hot pepper, sweet pepper and okra.

UNIT-III: Peas and beans, amaranth, chenopods and lettuce.

UNIT-IV: Gourds, melons, pumpkins and squashes.

UNIT-V: Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca.

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, palanological studies, selfing and crossing techniques in vegetable 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; molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding blocks.

Suggested Readings

Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons.
Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ.
Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons.
Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding- Principles and Prospects*. Chapman & Hall.
Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.
Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Regio*n. FAO.
Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables.* Revised, ICAR.
Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency.
Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani.
Simmonds NW. 1978. *Principles of Crop Improvement*. Longman.
Singh BD. 1983. *Plant Breeding*. Kalyani.
Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.
Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.

VSC 504 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS 2+1 SEM - I

Objective

To teach the physiology of growth and development of vegetable crops.

Theory

UNIT-I: Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production.

UNIT-II: Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

UNIT-III: Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance.

UNIT-IV: Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

UNIT-V: Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

Practical

Preparation of solutions of plant growth substances and their application; experiments in breaking and induction of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in Solanaceous vegetables; growth analysis techniques in vegetable crops.

Suggested Readings

Bleasdale JKA. 1984. *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan.

Gupta US. (Ed.). 1978. *Crop Physiology*. Oxford & IBH.

Krishnamoorti HN. 1981. *Application Plant Growth Substances and Their Uses in Agriculture*. Tata-McGraw Hill.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001. *Laboratory Manual of Analytical Techniques in Horticulture*. Agrobios.

Wien HC. (Ed.). 1997. *The Physiology of Vegetable Crops*. CABI.

VSC 505/ SST 504 SEED PRODUCTION IN VEGETABLES 2+1 SEM - II

Objective

To impart a comprehensive knowledge of seed production in vegetable crops with adequate practical training.

Theory

UNIT-I: Introduction; modes of propagation in vegetables; Seed morphology and development in vegetable seeds; Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops.

UNIT-II: Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. seed-to-seed vs. root-to-seed method in radish; seed multiplication ratios in vegetables; pollination mechanisms; sex types, ratios and expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage.

UNIT-III: Seed production technology of vegetables viz. solanaceous, cucurbitaceous, leguminous, malvaceous, Cole crops, leafy vegetables, root, tuber and bulb crops and spices; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato, sweet potato, colocasia, tapioca; seed-plot technique in potato tuber seed production; hybrid seed production technology of vegetable crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self incompatibility in hybrid seed production, environmental factors related to flowering/bolting in vegetable crops.

UNIT-IV: Share of vegetable seeds in seed industry; importance and present status of vegetable industry; intellectual property rights and its implications, impact of PVP on growth of seed industry.

Practical

Selection of suitable areas/locations for high quality seed/planting material production; study of floral biology of vegetables, determination of planting ratios for hybrid seed production vegetables; use and maintenance of monoecious line in hybrid seed production of cucumber; exercises on emasculation and pollination; seed extraction methods and their effect on quality of vegetables; seed production technology of varieties and hybrids in vegetables.

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH.

Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.

George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.

Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

More TA, Kale PB & Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.

Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

VSC 506 SYSTEMATICS OF VEGETABLE CROPS 1+1 SEM - I

(Unit-I to be taught by Botany)

Objective

To teach morphological, cytological, and molecular taxonomy of vegetable crops.

Theory

UNIT-I: Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.

UNIT-II: Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables.

UNIT-III: Cytological level of various vegetable crops; descriptive keys for important vegetables.

UNIT-IV: Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

Suggested Readings

Chopra GL. 1968. *Angiosperms - Systematics and Life Cycle*. S. Nagin.

Dutta AC. 1986. *A Class Book of Botany*. Oxford Univ. Press.

Pandey BP. 1999. *Taxonomy of Angiosperm*. S. Chand & Co.

Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised), ICAR.

Soule J. 1985. *Glossary for Horticultural Crops*. John Wiley & Sons.

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

Vasistha. 1998. *Taxonomy of Angiosperm*. Kalyani.

Vincent ER & Yamaguchi M. 1997. *World Vegetables*. 2nd Ed. Chapman & Hall.

VSC 507 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS 2+1 SEM - I

Objective

To educate production technology of underexploited vegetable crops.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, owing/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: Asparagus, artichoke and leek.

UNIT-II: Brussels sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT-III: Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.

UNIT-IV: Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT-V: Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

Practical

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

Suggested Readings

Bhat KL. 2001. *Minor Vegetables - Untapped Potential*. Kalyani.

lndira P & Peter KV. 1984. *Unexploited Tropical Vegetables*. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. *Underutilized and Underexploited Horticultural Crops*. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

VSC 508 ORGANIC VEGETABLE PRODUCTION TECHNOLOGY 1+1 SEM - II

Objective

To educate principles, concepts and production of organic farming in vegetable crops.

Theory

UNIT-I: Importance, principles, perspective, concept and component of organic production of vegetables.

UNIT-II: Organic production of vegetables crops, *viz.,* Solanaceous crops, cucurbits, cole crops, root and tuber crops.

UNIT-III: Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT-IV: Methods for enhancing soil fertility, mulching, raising green manure crops, indigenous methods of compost, Panchagavvya, Biodynamics, preparation etc Pest and disease management in organic farming; ITKõs in organic farming. Role of botanicals and bio-control agents.

UNIT-V: GAP and GMP- Certification of organic products; organic production and export-opportunity and challenges.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waster management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

Suggested Readings

Dahama AK. 2005. *Organic Farming for Sustainable Agriculture*. 2nd Ed. Agrobios.

Gehlot G. 2005. *Organic Farming; Standards, Accreditation Certification and Inspection*. Agrobios.

Palaniappan SP & Annadorai K. 2003. *Organic Farming, Theory and Practice*. Scientific Publ.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.

Shivashankar K. 1997. *Food Security in Harmony with Nature*. 3rd IFOAM-ASIA, Scientific Conf.. 1- 4 December, 1997, UAS, Bangalore.

VSC 509 FUNDAMENTALS OF PROCESSING OF VEGETABLES 2+1 SEM - II

Objective

To educate principles and practices of processing of vegetable crops.

Theory

UNIT-I: Present status and future prospects of vegetable preservation industry in India.

UNIT-II: Spoilage of processed horticultural products; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms, food poisoning and their control measures. role of microorganisms in food preservation.

UNIT-III: Raw materials for processing, Primary and minimal processing; processing equipments; Importance of hygiene; Plant sanitation.

UNIT-IV: Quality assurance and quality control, Food standards ï FPO, PFA, etc. Food laws and regulations.

UNIT-V: Food safety ï Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.

UNIT-VI: Major value added products from vegetables. Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.

UNIT-VII: Principles and methods of sensory evaluation of processed vegetables.

Practical

Study of machinery and equipments used in processing of horticultural produce; Chemical analysis for nutritive value of processed vegetables; Study of different types of spoilage in processed horticultural produce; study of biochemical changes and enzymes associated with spoilage; Laboratory examination of vegetable products; Sensory evaluation of processed vegetables; study of food standards ï National, international, CODEX Alimentarius; Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.

Suggested Readings

Arthey D & Dennis C. 1996. *Vegetable Processing*. Blackie/Springer-Verlag.

Chadha DS. 2006. *The Prevention of Food Adulteration Act*. Confed. of Indian Industry.

Desrosier NW. 1977. *Elements and Technology*. AVI Publ. Co.

FAO. 1997. *Fruit and Vegetable Processing*. FAO.

FAO. *CODEX Alimentarius*: Joint FAO/WHO Food Standards Programme. 2nd Ed. Vol. VB. *Tropical Fresh Fruits and Vegetables*. FAO.

FAO. *Food Quality and Safety Systems – Training Manual on Food Hygiene and HACCP*. FAO.

Fellowõs P. 1988. *Food Processing Technology*. Ellis Horwood International.

Frazier WC & Westhoff DC. 1995. *Food Microbiology*. 4th Ed. Tata McGraw Hill.

Giridharilal GS, Siddappa & Tandon GL. 1986. *Preservation of Fruits and Vegetables*. ICAR.

Gisela J. 1985. *Sensory Evaluation of Food – Theory and Practices*. Ellis Horwood.

Graham HD. 1980. *Safety of Foods*. AVI Publ. Co.

Hildegrade H & Lawless HT. 1997. *Sensory Evaluation of Food*. CBS.

Joslyn M & Heid. *Food Processing Operations*. AVI Publ. Co.

Mahindru SN. 2004. *Food Safety: Concepts and Reality*. APH Publ. Corp.

Ranganna S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw Hill.

Shapiro R. 1995. *Nutrition Labeling Handbook*. Marcel Dekker.

Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation: Principles and Practices*. 3rd Ed. International Book Distri. Co.

Tressler & Joslyn MA. 1971. *Fruit and Vegetable Juice Processing Technology*. AVI Publ. Co.

Verma LR & Joshi VK. 2000. *Post-harvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publ. Co.

VSC 510/ PSMA 502 PRODUCTION TECHNOLOGY OF SPICE CROPS 2+1 SEM - II

Objective

To impart basic knowledge about importance and production technology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site election, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT-I: Black pepper, cardamom.

UNIT-II: Clove, cinnamon and nutmeg, allspice.

UNIT-III: Turmeric, ginger and garlic.

UNIT-IV: Coriander, fenugreek, cumin, fennel, ajowain, dill, celery.

UNIT-V: Tamarind, garcinia and vanilla.

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term experiments on spice crops.

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production, Quality, Export*. Pointer Publ.

Arya PS. 2003. *Spice Crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ.

Bose TK, Mitra SK, Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol. I. Naya Prokash.

Chadha KL & Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.

Gupta S. (Ed.). *Hand Book of Spices and Packaging with Formulae*. Engineers India Research Institute, New Delhi.

Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.

Nybe EV, Miniraj N & Peter KV. 2007. *Spices*. New India Publ. Agency.

Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.

Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC USA.

Pruthi JS. (Ed.). 1998. *Spices and Condiments*. National Book Trust.

Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management and Post Harvest Technology*. ICAR.

Purseglove JW, Brown EG, Green CL & Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.

Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.

Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.

Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co.

Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

VSC 511 POST HARVEST TECHNOLOGY OF VEGETABLE CROPS 2+1 SEM - II

Objective

To facilitate understanding on principles, and to acquaint with the proper handling and management technologies of vegetable crops for minimizing post harvest losses.

Theory

UNIT-I: Importance and scope of post harvest management of vegetables.

UNIT-II: Maturity indices and standards for different vegetables; methods of maturity determinations; biochemistry of maturity and ripening, enzymatic and textural changes, ethylene evolution and ethylene management, respiration, transpiration, regulation methods.

UNIT-III: Harvesting tools, harvesting practices for specific market requirements; post-harvest physiological and biochemical changes, disorders-chilling injury in vegetables, influence of pre-harvest practices and other factors affecting post harvest losses, packaging house operations, commodity pretreatments- chemicals, wax coating, prepackaging and irradiation; packaging of vegetables, post harvest, diseases and prevention from infestation, principles of transport.

UNIT-IV: Methods and practices of storage- ventilated, refrigerated, MA, CA storage, hypobaric storage, pre-cooling and cold storage, zero energy cool chamber; storage disorders.

Practical

Studies on stages and maturing indices and ripening of commercially important vegetable crops, studies of harvesting, pre cooling, pre treatments, pre packaging, physiological disorders - chilling injury, improved packing, use of chemicals for ripening and enhancing shelf life of vegetables, physiological loss in weight of vegetables estimation of transpiration, respiration rate, ethylene release, storage of important vegetables, cold chain management - visit to commercial packaging house, cold storage and CA storage.

VSC 601 ADVANCES IN VEGETABLE PRODUCTION 2+1 SEM - I

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and bio-fertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost poly house; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT-I: Tomato, brinjal, chilli, sweet pepper and potato.

UNIT-II: Cucurbits, cabbage, cauliflower and knol-khol.

UNIT-III: Bhendi, onion, peas and beans, amaranthus and drumstick.

UNIT-IV: Carrot, beet root and radish.

UNIT-V: Sweet potato, tapioca, elephant foot yam and taro.

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dry land techniques for rain-fed vegetable production; production constraints; analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ;marketing survey of the above crops; visit to vegetable and fruit malls and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI.

FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.
Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.
Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.
Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.
Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

VSC 602 ADVANCES IN BREEDING OF VEGETABLE CROPS 2+1 SEM - II

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolution, distribution, cyto-genetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, inter-specific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of:

UNIT-I: Tomato, brinjal, chilli, sweet pepper and potato.
UNIT-II: Cucurbits, Cabbage, cauliflower and knol-khol.
UNIT-III: Bhendi, onion, peas and beans, amaranths and drumstick.
UNIT-IV: Carrot, beet root and radish.
UNIT-V: Sweet potato, tapioca, elephant foot yam and taro.

Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for-quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

Suggested Readings

Acta Horticulture. Conference on Recent Advance in Vegetable Crops. Vol. 127.
Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House.
Chadha KL. 2001. *Hand Book of Horticulture*. ICAR.
Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co.
Kalloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.
Kalloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks.
Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.
Ram HH. 2001. *Vegetable Breeding*. Kalyani.

VSC 603 PROTECTED CULTIVATION OF VEGETABLE CROPS 1+1 SEM - I

Objective

To impart knowledge in growing of vegetable crops under protected environmental conditions.

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce.

UNIT-I: Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT-II: Regulatory structures used in protected structures; types of greenhouse/poly house/net-house, hot beds, cold frames, effect of environmental factors, *viz.* temperature, light, CO2 and humidity on growth of different vegetables, manipulation of CO2, light and temperature for vegetable production, fertigation.

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 vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

UNIT-V: Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.

Practical

Study of various types of structures, methods to control temperature, CO2 light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/poly house/net house/shade house in the region.

Suggested Readings

Anonymous 2003. *Proc. All India Seminar on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

Chandra S & SomV. 2000. *Cultivating Vegetables in Green House*. *Indian Horticulture* 45: 17-18.

Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2nd Ed. Agrobios.

Tiwari GN. 2003. *Green House Technology for Controlled Environment*. Narosa Publ. House.

VSC 604/ FLA605/ MBB 604 **ADVANCES IN CROP BIOTECHNOLOGY** **3+0** **SEM - I**

(To be taught by Molecular Biology & Biotechnology)

Objective

To teach advances in biotechnology for improvement of vegetable crops.

Theory

UNIT-I: Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available tissue culture, transformation, molecular marker and genomic tools for crop improvement.

UNIT-II: Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc); edible vaccines, etc.

UNIT-III: Molecular breeding; constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and phylogenitic analysis; molecular tagging of genes/traits; selected examples on marker assisted selection of qualitative and quantitative traits.

UNIT-IV: Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major cereal, legume oilseed, vegetable and horticultural crops.

Suggested Readings

Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry*. Vol.XIX. *Hitech and Micropropagation*. Springer.

Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops*. Malhotra Publ. House.

Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ.

Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.
Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.
Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer.* Orient & Longman (Universal Press).
Keshavachandran R et al. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency.
Panopoulas NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.
Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.
Sharma R. 2000. *Plant Tissue Culture*. Campus Books.
Singh BD.2001. *Biotechnology*. Kalyani.
Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro.* Attidel. II Symp. on Biotechnology Action of Growth Substance.
Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.
Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V.

VSC 605 ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS 2+1 SEM - II

(Pre-requisite MBB 501)

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, sub tropical and temperate crops grown in India.

Theory

UNIT-I: Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of anti-transpirants.

UNIT-II: Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

UNIT-III: Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

UNIT-IV: Techniques of vegetable growing under water deficit, water logging, salinity, and sodicity.

UNIT-V: Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Practical

Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops, measurement of tolerance to various stresses in vegetable crops, short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

Suggested Readings

Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.
Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.
Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.

VEGETABLE SCIENCE

List of Journals

- American Journal of Horticultural Sciences
- American Potato Growers
- American Scientist
- Annals of Agricultural Research
- Annual Review of Plant Physiology
- California Agriculture
- Haryana Journal of Horticultural Sciences
- HAU Journal of Research
- Horticulture Research
- HortScience
- IIVR Bulletins
- Indian Horticulture
- Indian Journal of Agricultural Sciences
- Indian Journal of Horticulture
- Indian Journal of Plant Physiology
- Journal of American Society for Horticultural Sciences
- Journal of Arecanut and Spice Crop
- Journal of Food Science and Technology
- Journal of Plant Physiology
- Journal of Post-harvest Biology and Technology
- Post-harvest Biology and Technology
- Scientia Horticulturae
- Seed Research
- Seed Science
- South Indian Horticulture
- Vegetable Grower
- Vegetable Science

Suggested Broad Topics for Master's and Doctoral Research

- Organic farming in vegetable crops
- Application of molecular markers in genetic improvement of vegetable crops
- Development of transgenic vegetables
- Growing vegetables under protected conditions
- Mulching in vegetable crops
- Micronutrients in vegetable crops
- Screening of vegetable s against abiotic stress
- Hi-tech methods for raising nursery of vegetable crops
- Dry land and coastal farming
- Drip/micro irrigation in vegetable crops
- Fertigation in vegetable crops
- Research on physiological disorders in vegetable crops
- Breeding for quality improvement
- Breeding for insect-pest and disease resistance
- Breeding for extending shelf life of vegetable crops
- Minimal processing of vegetables
- Concept of quality control in vegetable seed production
- Integrated nutrients management in vegetable crops
- Breeding for industrial and processing of vegetable crops
- Research on water management in vegetable crops
- Research on home storage of vegetable crops
- Hi-tech home gardening