

## Resolution

We the undersigned convenors of the following P.G. Subjects have re-structured the respective courses as per ICAR latest guidelines on the meeting held on 05/09/2017 alongwith Dr. Jyoti Shanker, Principal, K.A.P.G. College, Allahabad.

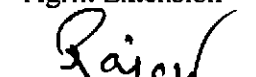
- 1- Agricultural Economics
- 2- Agricultural Extension
- 3- Genetics & Plant Breeding
- 4- Horticulture
- 5- Soil Science & Agricultural Chemistry

The nomenclature of earlier Ag. Botany & Ag. Chemistry be changed as Genetics & Plant Breeding, Soil Science & Agricultural Chemistry respectively in view of existing subjects names in other Universities.

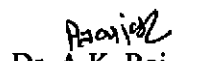
The restructured syllabus of the above courses are submitted for your kind approval w.e.f 2017-18



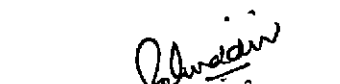
Dr. Ravi Prasad  
Convenor  
Agril. Extension




Dr. Rajendra Prasad  
Convenor  
Horticulture




Dr. A.K. Rai  
Convenor  
Agril. Economics



Dr. Salimuddin  
Convenor  
Genetics & Plant Breeding



Dr. R.L. Pal  
Convenor  
Soil Science & Agril. Chemistry



Dr. Jyoti Shanker  
Principal

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

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



**Submitted by :**

***Conveners Board of Studies in Agriculture***

**Kulbhaskar Ashram P.G. College, Allahabad - 211001**

**Affiliated Allahabad State University**

**Allahabad - 211001**

## M.Sc. (Ag.) AGRICULTURAL ECONOMICS

I <sup>st</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 501	Micro Economic Theory and Applications	3(3+0)	20	-	80	100
AGECON504	Agricultural Production Economics	3(2+1)	20	30	50	100
AGECON506	Research Methodology for Social Sciences	3(2+1)	20	30	50	100
	Computer Application in Agriculture	2 (1+1)	20	30	50	100
	<b>Total Credit</b>	<b>11</b>				
II <sup>nd</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 502	Macro Economics and Policy	3(3+0)	20	-	80	100
AGECON505	Agricultural Marketing & Price Analysis	3(2+1)	20	30	50	100
AGECON509	Agricultural Finance and Project Management	3(2+1)	20	30	50	100
	Agricultural Statistics	3(2+1)	20	30	50	100
	<b>Total Credit</b>	<b>12</b>				
III <sup>rd</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 507	Econometric	3(2+1)	20	30	50	100
AGECON 515	Rural Marketing	3(3+1)	20	30	50	100
AGECON508	Linear Programming	2(1+1)	20	30	50	100
AGECON503	Evaluation of Thought	3(3+0)	20	-	80	100
	<b>Total Credit</b>	<b>11</b>				
IV <sup>th</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 591	Masters Seminar	1	-	-	-	100
AGECON 599	Masters Research	20	-	-	-	100
	<b>Total Credit</b>	<b>21</b>				
	<b>Total Credit Hours</b>	<b>55</b>				

*Asad*

# Agricultural Economics

## Course Contents

### AGECON 501 MICRO ECONOMIC THEORY AND APPLICATIONS 3(3+0)

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

#### Theory

UNIT I: Theory of Consumer Behaviour - Cardinal Utility Approach - Ordinal Utility Approach – Income effect and substitution effect – Applications of Indifference curve approach - Revealed Preference Hypothesis – Consumer surplus - Derivation of Demand curve – Elasticity of demand.

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

UNIT III: Market Equilibrium - Behavior of Firms in Competitive Markets – Perfect Competition- Effect of Taxation and Subsidies on market equilibrium - Monopoly- Monopolistic - Oligopoly- Theory of Factor Markets.

UNIT IV: General Equilibrium Theory - Welfare Economics - Pareto Optimality – Social welfare criteria - Social Welfare functions.

#### Suggested Readings

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

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

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

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

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

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

**AGECON 502          MACRO ECONOMICS AND POLICY          3(3+0)**

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

**Theory**

UNIT I: Nature and Scope of Macro Economics - Methodology and Keynesian Concepts  
National Income - Concepts and measurement- Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand.

UNIT II: Consumption function- Investment and savings - Concept of Multiplier and Accelerator - Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version- Classical theory Vs Keynesian theory – Unemployment and Full employment.

UNIT III: Money and classical theories of Money and Price - Keynesian theory of money and Friedman Restatement theory of money - Supply of Money - Demand for Money -Inflation: Nature, Effects and control.

UNIT IV: IS & LM frame work - General Equilibrium of product and money markets - Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy - Central banking.

UNIT V: Business cycles - Balance of Payment - Foreign Exchange Rate determination.

**Suggested Readings**

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

Eugene A Diulio 2006. *Macroeconomics*. 4th Ed. Schaums' Outlines.

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

Dornbusch. 2006. *Macroeconomics*. McGraw Hill Publication

**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 I

Approaches for the study of history of economic thought – Absolutist vs. Relativist approaches – Evolution of Economic Thought vs. Economic History. Ancient economic thought – medieval economic thought – mercantilism – physiocracy – Forerunners of Classical Political Economy.

UNIT II

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

UNIT III

The birth of neoclassical economic thought – Marshall and Walras – General Equilibrium Theory - Welfare Theory – Keynesian economics.

UNIT IV

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

UNIT V

Economic Thought in India – Naoroji and Gokhale – Gandhian Economics  
-  
Economic thought of independent India – Nehru's economic

philosophy

Experiences of the Structural adjustment programmes of the post liberalization era.

### **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.

## **AGECON 504      AGRICULTURAL PRODUCTION ECONOMICS      3(2+1)**

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

### **Theory**

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

**UNIT II:** Factors of production, classification, interdependence, and factor substitution - Determination of optimal levels of production and factor application –Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.

**UNIT III:** Cost functions and cost curves, components, and cost minimization – Duality theory – cost and production functions and its applications -

Derivation of firm's input demand and output supply functions -Economies and diseconomies of scale.

UNIT IV: Technology in agricultural production, nature and effects and measurement - Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.

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

#### **Suggested Readings**

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

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

Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics*. Vol. 1. *Agricultural Production*. Elsevier.

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

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

### **AGECON 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 3(2+1)**

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

#### **Theory**

UNIT I: Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural



Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.

UNIT II: Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies – Market infrastructure needs, performance and Government role - Value Chain Finance.

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

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

UNIT V: Theory of storage - Introduction to Commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis - Role of Government in promoting commodity trading and regulatory measures.

**Practical:** Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Chain Analysis - quantitative estimation of supply chain efficiency - Market Intelligence – Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports –commodity outlook - Technical Analysis for important agricultural commodities - Fundamental Analysis for important

agricultural commodities - Presentation of the survey results and wrap-up discussion.

### **Suggested Readings**

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

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

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

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

## **AGECON 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 3(2+1)**

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

### **Theory**

UNIT I: Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.

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

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

UNIT IV: Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended

questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.

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

**Practical:** Exercises in problem identification. Project proposals – contents and scope. Formulation of Objective and hypotheses. Assessment of data needs – sources of data – methods of collection of data. Methods of sampling – criteria to choose – discussion on sampling under different situations. Scaling Techniques – measurement of scales. Preparation of interview schedule - Field testing. Method of conducting survey. Exercise on coding, editing, tabulation and validation of data. Preparing for data entry into computer. Hypothesis testing – Parametric and Non-Parametric Tests. Exercises on format for Thesis / Report writing. Presentation of the results.

### **Suggested Readings**

- Black TR. 1993. *Evaluating Social Science Research - An Introduction*. SAGE Publ.
- Creswell JW. 1999. *Research Design - Qualitative and Quantitative Approaches*. SAGE Publ.
- Dhondyal SP. 1997. *Research Methodology in Social Sciences and Essentials of Thesis Writing*. Amman Publ. House, New Delhi.
- Kothari CR. 2004. *Research Methodology - Methods and Techniques*. Wishwa Prakashan, Chennai.
- Rao KV. 1993. *Research Methodology in Commerce and Management*. Sterling Publ., New Delhi.
- Singh AK. 1993. *Tests, Measurements and Research Methods in Behavioural Sciences*. Tata McGraw-Hill.
- Venkatasubramanian V. 1999. *Introduction to Research Methodology in Agricultural and Biological Sciences*. SAGE Publ.

**Objective**

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

**Theory**UNIT I

Introduction – relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics- regression analysis.

UNIT II

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

UNIT III

Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model misspecification.

UNIT IV

Use of dummy variables-limited dependent variables – specification, estimation and interpretation.

UNIT V

Simultaneous equation models – structural equations - reduced form equations - identification and approaches to estimation.

**Practical**

Single equation two variable model specification and estimation - hypothesis testing- transformations of functional forms 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 and Row Publ.

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.

**AES 508**

**LINEAR PROGRAMMING**

**2(1+1 )**

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

### **Theory**

UNIT I: Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, 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 Publication

**AGECON 509 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT 3(2+1)**

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

**Theory**

UNIT I :Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing - Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II: Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

UNIT III: Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV: Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

UNIT V: Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes – yield loss and weather based insurance and their applications.

#### **Practical**

Development of Rural Institutional Lending - Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving- : An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme- Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies – crop insurance schemes, Financial instruments and methods – E banking, Kisan Cards and core banking.

#### **Suggested Readings**

Dhubashi PR. 1986. *Policy and Performance - Agricultural and Rural Development in Post Independent India*. Sage Publ.

Gittinger JP 1982. *Economic Analysis of Agricultural Projects*. The Johns Hopkins Univ. Press.

Gupta SC. 1987. *Development Banking for Rural Development*. Deep & Deep Publ.

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

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

**AGECON 515**

**RURAL MARKETING**

**3(2+1)**

**Objective**

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

**Theory**

UNIT I

Concept and scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India.

UNIT II

Environmental factors - socio-cultural, economic and other environmental factors affecting rural marketing.

UNIT III

Rural consumer's 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.

**Practical** – Survey of Rural market both Primary and Secondary case study of marketing of a minor and major commodity with respect to rural marketing channels.



Casts, margin and market price spread, market performance and Rural market efficiency. On line searches for Rural market information sources and interpretation of market intelligence report, submission of a report on above all aspects.

#### **Suggested Readings**

- Krishnamacharyulu CSG & Ramakrishan L. 2002. *Rural Marketing*. Pearson Edu. Ramaswamy VS & Nanakumari S. 2006. *Marketing Management*. 3<sup>rd</sup> Ed. MacMillan.
- Singh AK & Pandey S. 2005. *Rural Marketing*. New Age.
- Singh Sukhpal. 2004. *Rural Marketing*. Vikas Publ. House.

## M.Sc. (Ag.) AGRICULTURAL EXTENSION

<b>I<sup>st</sup> Semester</b>			<b>Evaluation Marks</b>			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 511M	Development Perspective of Extension Education	3(2+1)	20	30	50	100
EXT 512 M	Development Communication and Information Management	3(2+1)	20	30	50	100
EXT 513 M	Diffusion and Adoption of Innovations	3(2+1)	20	30	50	100
	Computer Application in Agriculture	2(1+1)	20	30	50	100
	<b>Total Credit</b>	<b>11</b>				
<b>II<sup>nd</sup> Semester</b>			<b>Evaluation Marks</b>			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 522 M	Entrepreneurship Development and Management in Extension	3(2+1)	20	30	50	100
EXT 523M	Human Resource Development	3(2+1)	20	30	50	100
EXT 524	Participatory methods for technology Development and transfer	3(2+1)	20	30	50	100
	Agricultural Statistics	3(2+1)	20	30	50	100
	<b>Total Credit</b>	<b>12</b>				
<b>III<sup>rd</sup> Semester</b>			<b>Evaluation Marks</b>			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 521M	E-Extension	3(2+1)	20	30	50	100
EXT 531	Research methods in behavioral sciences	3(2+1)	20	30	50	100
EXT 532	Visual Communication	3(2+1)	20	30	50	100
EXT 611	Advances in Agricultural Extension	2(1+1)	20	30	50	100
	<b>Total Credit</b>	<b>11</b>				
<b>IV<sup>th</sup> Semester</b>			<b>Evaluation Marks</b>			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 591	Masters Seminar	1	-	-	-	100
EXT 599	Masters Research	20	-	-	-	100
	<b>Total Credit</b>	<b>21</b>				
	<b>Total Credit Hours</b>	<b>55</b>				

## **M.Sc. (Ag) Programme**

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

### **Objective**

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

### **Theory**

Extension Education — Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions — Extension Education as a Profession — Adult Education and Distance Education. Pioneering Extension efforts and their implications in Indian Agricultural Extension — Analysis of Extension systems of ICAR and SAU — State Departments Extension system and NGOs — Role of Extension in Agricultural University. Poverty Alleviation programmes - SGSY, SGRY, PMGSY, DPAP, DDP, CAPART — Employment Generation Programmes — NREGP, women Development Programmes — ICDS, MSY, RMK, Problems in Rural Development. Current Approaches in extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market — Led — Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

### **Practical**

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

### **Suggested Readings**

- Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. Extension Education What? And What Not ? RBSA publ.
- Gallagher K. 1999. Farmers Field School (FES) — A Group Extension Process based on Non-Formal Education methods. Global EPM Facility, FAO.
- Gancsan R, Iqbal IM & Anandaraja N. 2003. Reaching the Unreached: Basics of Extension Education. Associated Publishing com.
- 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 512      Development Communication And Information Management      3(2+1)**

### **Objective**

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

### **Theory**

Communication process — concept, elements and their characteristics — Models and theories of communication — Communication skills— fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication — barriers in communication, Message — Meaning, dimensions of a message, characteristics of a good message, message treatment and effectiveness, distortion of message. Methods of communication — Meaning and functions, classification. Forms of communication Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators — Meaning, characteristics and their role in development. Media in communication — Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media — Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications. Agricultural Journalism as a means of mass communication. Its form and role in rural development, Basics of writing — News stories, feature articles, magazine articles farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures. Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

### **Practical**

Writeng News for Farm News paper/Magazines. Reporting of Various Extension activities like-Field day, Training, result Demonstration and farmer' fair etc. Preparing and delivering effective speech. Handling of communication and recording equipments (like-Computer,

P.A.System & Camera). Script writing for Radio, T.V. Conducting students' visit to Radio & T.V. station

### **Suggested Readings**

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

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

Jana B1 & Mishra K P. 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 A S. 2004. 1 extbook on Agricultural Communication Process and Methods. Oxford & IBH.

**EXT 513**

**Diffusion and Adoption of Innovations**

**3(2+1)**

### **Objective**

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

### **Theory**

Diffusion — concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice. The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process — a critical appraisal of the new formulation. Adopter categories — Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption. Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi -step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions — Optional, Collective and Authority and contingent innovation decisions; Consequences of

Innovation-Decisions — Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making — meaning, theories, process, steps, factors influencing decision — making.

### **Practical**

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

### **Suggested Readings**

- Dasgupta 1989. Diffusion of Agricultural Innovations in Village India. Wiley Eastern.  
Jalihal KA & Veerabliadraiah V. 2007. Fundamentals of Extension Education and Management in Extension. Concept Publ. Co.  
Ray G L. 2005. Extension Communication and Management. Kalyani Publ.  
Reddy AA. 1987. Extension Education. Sree Lakshmi Press, Bapatla.  
Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

**EXT 521**

**e- Extension**

**3(2+1)**

### **Objective**

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

### **Theory**

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs. advantages, limitations and opportunities. 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. Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts. 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**

Agri 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**

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

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

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

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

### **Objective**

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

### **Theory**

Entrepreneurship — Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri —entrepreneurship — Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs - Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Intrepreneurs. Stages of establishing enterprise — Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project \ management and Appraisal — Market, Technical, Financial, Social Appraisal of Projects. Management — Meaning, concept. nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management — Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning — Concept, Nature, Importance, Types, Making planning effective. Change Management — factors, process and procedures.

Decision making — Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing — meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, authority and responsibility, Delegation and decentralization, line and staff relations. Coordination — Concept, Need, type techniques of Coordination. Interpersonal relations in the organization. Staffing — Need and importance, \Nonpo\\CF planning, Recruitment, Selection, Placement and Orientation, Training and Development — Performance appraisal meaning, Concept, Methods. Direction — Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership — Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication — Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation — Concept, Motivation and Performance, Approaches to motivation.

Supervision Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control - Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

### **Practical**

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

### **Suggested Readings**

- Gupta CB. 2001. Management Theory and Practice. Sultan Chand & Sons.  
Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.  
Khanka SS. 1999. Entrepreneurial Development. S. Chand & Co.  
Singh D. 1995. Effective Managerial Leadership. Deep & Deep Publ.  
Tripathi PC & Reddy PN. 1991. Principles of Management. Tata McGraw Hill.  
Vasanta Desai 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.



**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**

Human Resource Development — Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions — Different experiences, Selection, Development & Growth-Selection, Recruitment, Induction Staff Training and Development, career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure society in transition; Organizational and Managerial values and ethics, organizational commitment; innovation productivity -job description — analysis and evaluation; Performance Appraisal. Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process — communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition: HRD & Supervisors: Task Analysis; Capacity Building — Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager — Responsibility of Professional Manager; Managerial skills and Skills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics : Leadership styles — Group dynamics. Training — Meaning, determining training need and development strategies — Training types, models, methods and evaluation; Facilities for training — Trainers training, — techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate — organizing for HRD — emerging trends and Prospective.

**Practical**

Visit to different training organizations to review ongoing 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**

- Ageohiya D. 2002. Every trainers 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. 5<sup>th</sup> edition Prentice-Hall of India.
- Knoont / Harold Wehrich 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 Behavior. Himalaya Publ. House.
- Sundaram R M. Gupta V, George SS. 2006. Case Studies in Human Resource Management. ICFAI, Hyderabad.
- Tripathi & Reddy. 2004. Principles of Management. Tata McGraw-Hill.
- Wayne MR Robert MN. 2005. Human Resource Management. International Ed. Pearson Prentice Hall.

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

#### **Objective**

This course is intended to orient the students with the key concepts, principles process of different participatory approaches for technology development and transfer and also to expose the students with various participatory tools and techniques like space related, time related, relation oriented methods. Besides the students will be learning the preparation of action plans participatory monitoring and evaluation.

#### **Theory**

Participatory extension — importance, key features, principles and process of participatory approaches: Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models. Participatory tools and techniques. Space Related Methods : village map (social & resource), mobility services and opportunities Map and transect; Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule dream map; Relation oriented methods : cause and effect diagram (problem

tree), impact — diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis. 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 531**

**Research Methods In Behavioural Science**

**3(2+1)**

### **Objective**

This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the appropriate statistics for data analysis.

### **Theory**

Research - meaning, importance, characteristics. Behavioural sciences research — Meaning, concept and problems in behavioural sciences research. Types and methods of Research — Fundamental, Applied and Action research, exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature — Need, Search Procedure, Sources of literature, Planning the review work. Research problem — Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem. Objectives Meaning, types and criteria for judging the objectives. Concept and Construct — Meaning role of concepts in research and Conceptual frame work development in research. Variable — Meaning, type and their role in research. Definition — Meaning, characteristics of workable definitions, types and their role in research. Hypothesis —

Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement — Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity — Meaning and methods of testing. Reliability- Meaning and methods of testing. Sampling — Universe, Sample and Sampling-Meaning, basis for sampling advantages and limitations, size and factors affecting the size of the sample and sampling errors — Methods of elimination and minimizing, Maximincon Principle, Sampling — Types of sampling and sampling procedures. Research Designs — Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design — Advantages and limitations. Data Collection devices - Interview — Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules — Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires — Meaning, difference between schedule and questionnaire, types of questions to be used, pre — testing of the questionnaires or schedules and advantages and limitations. Check lists — Meaning, steps in construction, advantages and limitations in its use. Rating. scales — Meaning, types, limits in construction. advantages and limitations in its use. Observation — Meaning, types, tips in observation, advantages and limitations in its use. Case studies — Meaning, types, steps in conducting, advantages and limitations in its use. Social survey — Meaning, objectives, types and steps in conducting, advantages and limitations. Data processing — Meaning, coding, preparation of master code sheet, analysis and tabulation of data, choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing Meaning guidelines to be followed in scientific report writing, References in reporting.

### **Practical**

Selection and humiliation 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.- Pretesting of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, 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.

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

Mlulay 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.1 993. Alethodolgy and Techniques of Social Research. Himalaya Publ. Home.

**EXT 532**

**Visual Communication**

**3(2+1)**

### **Objective**

This course is intended to give a clear perspective about the importance of visuals and graphics in communication. The course starts with the delineating about the characteristics of visuals and graphics followed by its main functions, theories of visual perception and its classification and selection. Further, the course deals with the designing the message, graphic formats and devices and presentation of data. It makes the students to understand, prepare and present the scientific data effectively by using low cost visuals. The course also exposes the students to various Video material in multimedia and also enable to design visuals for print, TV and know-how about scanning of visual.

### **Theory**

Role of visuals & graphics in Communication Characteristics of visuals & graphics. Functions of visuals and Graphic theories of visual, perception classification and selection of visuals. Designing message for visuals, graphic formats and devices. Presentation of scientific data. Principles and production of low cost visuals. Photographs - reprographic visuals. PC based visual. Digitized video material in multimedia production Designing graphic for print and TV and video. Pre-testing and evaluation 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.

**EXT 611**

**Advances in Agricultural Extension**

**2(1+1)**

### **Theory**

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. 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. Stakeholders analysis in Extension. Main streaming gender in Extension - Issues and Prospects. 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. Extension and contemporary issues: Extension and issues-related to rural poverty. Privation 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 Centers.

### **Practical**

Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension. Analyses of ATMA and SREP. Practicing bottom up planning. Visit to –public private Farmer partnership. Learning from Food and Nutritional Security and bio-diversity Projects and programmes.

## M.Sc(Ag): Genetics & Plant Breeding

Code No.	Course Title	Credit	Marks			Total
			Theory	Practical	Mid Term	
GPB-501	Principles of Genetics	2+1	50	30	20	100
GPB-502	Principles of Cytogenetics	2+1	50	30	20	100
GPB-503	Principles of Plant Breeding	2+1	50	30	20	100
GPB-504	Principles of Quantitative Genetics	2+1	50	30	20	100
GPB-505	Mutagenesis and Mutation Breeding	2+1	50	30	20	100
GPB-506	Population Genetics	2+1	50	30	20	100
GPB-507	Heterosis Breeding	2+1	50	30	20	100
GPB-508	Cell Biology and Molecular Genetics	2+1	50	30	20	100
GPB-509	Biotechnology for Crop Improvement	2+1	50	30	20	100
GPB-515	Maintenance Breeding, Concepts of Variety Release and Seed Production	1+1	50	30	20	100
	Computer Application in Agriculture	1+1	50	30	20	100
	Agricultural Statistics	2+1	50	30	20	100
	<b>Total</b>	<b>34</b>				
<b>Semester wise Course Distribution:</b>						
<b>Ist Semester</b>						
GPB -501	Principles of Genetics	2+1	50	30	20	100
GPB-502	Principles of Cytogenetics	2+1	50	30	20	100
GPB-506	Population Genetics	2+1	50	30	20	100
	Computer Application in Agriculture	1+1	50	30	20	100
	<b>Total</b>	<b>11</b>				
<b>IInd Semester</b>						
GPB-503	Principles of Plant Breeding	2+1	50	30	20	100
GPB-504	Principles of Quantitative Genetics	2+1	50	30	20	100
GPB-505	Mutagenesis and Mutation Breeding	2+1	50	30	20	100
	Agricultural Statistics	0+1	50	30	20	100
	<b>Total</b>	<b>12</b>				
<b>IIIrd Semester</b>						
GPB-508	Cell Biology and Molecular Genetics	2+1	50	30	20	100
GPB-509	Biotechnology for Crop Improvement	2+1	50	30	20	100
GPB-515	Maintenance Breeding, Concepts of Variety Release and Seed Production	1+1	50	30	20	100
GPB-507	Heterosis Breeding	2+1	50	30	20	100
	<b>Total</b>	<b>12</b>				
<b>IVth Semester</b>						
GPB-591	Master Seminar	1	-	-	-	100
GPF-899	Masters Research	20	-	-	-	100
	<b>Total</b>	<b>20</b>				
	<b>G.Total</b>	<b>55</b>				





elements; Molecular chaperones and gene expression; Gene regulation in eukaryotes; RNA editing.

#### UNIT VII

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

#### UNIT VIII

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

#### UNIT IX

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

#### UNIT X

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

### **Practical**

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification-Electrophoresis-basic principles and running of amplified DNA-Extraction of proteins and isozymes-use of *Agrobacterium* mediated method and Biolistic gun; practical demonstrations- Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

### **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*. 4<sup>th</sup> Ed. John Wiley & Sons. Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India 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.

**GPB 502**

**PRINCIPLES OF CYTOGENETICS**

**3(2+1)**

**Objectives**

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

**Theory**

UNIT I

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

UNIT II

Chromosomal theory of inheritance — Cell Cycle and cell division — mitosis and meiosis; Differences, significance and deviations — 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 — endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

UNIT IV

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids-Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and

utilization in gene mapping and gene blocks transfer-Alien addition and substitution lines-creation and utilization; Apomixis-Evolutionary and genetic problems in crops with apomixes.

#### UNIT V

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

#### UNIT VI

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

#### **Practical**

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

to somaclonal variation; Polyploidy in ornamental crops,-Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization (GISH)

### **Suggested Readings**

- Becker K & Hardin. 2004. *The World of Cell*. 5<sup>th</sup> 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 Microtome's Formulary 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.
- Johatmson 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.

**Objectives**

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

**Theory**UNIT I

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

UNIT II

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

UNIT III

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

UNIT III

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

UNIT IV

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S<sub>1</sub> and S<sub>2</sub> progeny testing, progeny selection schemes, recurrent selection schemes for intra-and inter-population improvement and development of synthetics and composites; Hybrid breeding-genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

## UNIT V

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

## UNIT VI

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

## UNIT VII

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

## UNIT VIII

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

### **Practical**

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

### **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.

**GPB 504                      PRINCIPLES OF QUANTITATIVE GENETICS                      3(2+1)**

**Objectives**

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

**Theory**

UNIT I

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

UNIT II

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

UNIT III

Designs for plant breeding experiments-principles and applications; Genetic diversity analysis-metroglyph, cluster and  $D^2$  analyses-Association analysis-phenotypic and genotypic correlations; Path analysis and parent-progeny regression analysis; Discriminant function and principal component analyses; Selection indices-selection of parents; Simultaneous selection models-concepts of selection-heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs-Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis

of genotype x environment interaction-adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis- principles and interpretation.

#### UNIT V

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

#### **Practical**

Problems on multiple factors inheritance-partitioning of variance-Estimation of heritability and genetic advance-Covariance analysis-Metroglyph analysis- $D^2$  analysis-Grouping of clusters and interpretation-Cluster analysis-Construction of cluster diagrams and dendrograms-interpretation-correlation analysis-Path analysis-Parent-progeny regression analysis-Diallel analysis: Griffing's methods I and II-Diallel analysis: Hayman's graphical approach-Diallel analysis: interpretation of results-NCD and their interpretations-Line x tester analysis and interpretation results-Estimation of heterosis: standard, mid-parental and better-parental heterosis-Estimation of inbreeding depression-Generation mean analysis: Analytical part and interpretation-Estimation of different types of gene actions.

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

#### **Suggested Readings.**

Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.



- Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman.
- Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.
- Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
- Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.
- Naryanan SS & 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 505 MUTAGENESIS AND MUTATION BREEDING 3(2+1)**  
**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 — paramutations.

UNIT II

Mutagenic agents: physical -- Radiation types and sources: Ionising and non-ionizing radiations viz., X rays,  $\gamma$  rays,  $\alpha$  and  $\beta$  particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (, photoelectric absorption, Compton scattering, and pair production) and their biological effects — 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  $M_1$  generation -Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations — 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 the same species – Case studies.

#### UNIT VII

Use of mutagens in creating oligogenic and polygenic variations – Case studies - *In vitro*. mutagenesis – callus and pollen irradiation; Handling of segregating generations and selection procedures; Validation of mutarfts; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement,etc) in different crops- 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 –Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards -

Monitoring – 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  $M_1$  generation – Parameters to be observed; Study of  $M_2$  generation – Parameters to be observed; Mutation breeding in cereals and pulses – Achievements made and an analysis -Mutation breeding in oilseeds and cotton – Achievements and opportunities - Mutation breeding in forage crops and vegetatively propagated crops; Procedure for detection of mutations for polygenic traits in  $M_2$  and  $M_3$  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.
- International Atomic Energy Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energy Agency, Vienna, Italy.
- Singh BD. 2003. *Genetics*. Kalyani.
- Strickberger MW. 2005. *Genetics*. 3<sup>rd</sup> Ed. Prentice Hall.

#### **GP 506 Objective**

#### **POPULATION GENETICS**

**3(2+1)**

To impart knowledge on structure, properties and their breeding values of different population.

#### **Theory**

##### UNIT I

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

##### UNIT II

Hardy-Weinberg equilibrium - Hardy-Weinberg law - Proof - Applications of the

Hardy-Weinberg law - Test of Hardy-Weinberg equilibrium - Mating frequencies - Non-dominance - Codominance - Snyder's ratio; importance and its effect over random mating in succeeding generations.

### UNIT III

Multiple alleles - More than one locus - Sex linked genes; Use of gene and genotypic frequencies evaluation in field population level; Interpretations -Changes of gene frequency - Migration — Mutation - Recurrent and non-recurrent - Selection - Balance between selection and mutation - Selection favouring heterozygotes - Overdominance for fitness.

### UNIT IV

Non random mating: selfing —inbreeding coefficient - panmictic index — sibmating - Assortative mating and disassortative mating - Pedigree populations and close inbreeding - Estimation of selection - Estimation of disequilibrium - Estimation of linkage - Correlation between relatives and estimation of F; Effect of inbreeding and sibbing in cross pollinated crops. UNIT V  
Gene substitution and average effects; Breeding value- 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.

### **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- Cavalli's joint scaling test; Exercises of different mating designs; Estimation of different population parameters from experimental data; Measurement of genotype-environment interaction; Genetic divergence.

### **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, Jain J & Parbhakaran, VT. 1992. *Genetics of Populations*. South Asia Books.

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 507**

**HETEROSIS BREEDING**

**3(2+1)**

**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 inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops.

UNIT II

Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis — 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 — case studies. - Relationship between genetic distance and expression of heterosis — 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 — 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; 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 its exploitation in heterosis.

## UNIT VII

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

### **Practical**

Selection indices and selection differential — Calculations and interpretations - 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 — 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**

Proceedings of *Genetics and Exploitation of Heterosis in Crops* - An International Symposium CIMMYT, 1998.

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*. 3<sup>rd</sup> Ed. Sinauer Assoc. Mettler LE &

Gregg TG. 1969. *Population Genetics and Evolution*.

Prentice-Hall.

Montgomery DC. 2001. *Design and Analysis of Experiments*. 5<sup>th</sup> 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.

**GPB 508      CELL BIOLOGY AND MOLECULAR GENETICS      3(2+1)**

**Objective**

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

**Theory**

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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.

**Practical**

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

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

### **Suggested Readings**

- Bruce A.2004. *Essential Cell Biology*. Garland.  
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. *IX Genes*. John Wiley & Sons  
Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5<sup>th</sup> Ed.  
WH Freeman.  
Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*.  
WH Freeman & Co.  
Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.  
Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.

**GPB 509                      BIOTECHNOLOGY FOR CROP IMPROVEMENT                      3(2+1)**

### **Objective**

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

### **Theory**

#### UNIT I

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

#### UNIT II

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

#### UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; • Vectors, vector preparation and cloning.



Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F<sub>2</sub>s, back crosses, RILs, NILs and DH).

#### UNIT IV

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

#### UNIT V

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

#### UNIT VI

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

#### UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming

#### UNIT VIII

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

#### UNIT 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 —interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

### 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*. 2<sup>nd</sup> Ed. Benjamin Publ. Co.
- Sambrook J & Russel D. 2001. *Molecular Cloning - a Laboratory Manual*. 3rd Ed. Cold Spring Harbor Lab. Press.
- Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

## MAINTENANCE BREEDING AND CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION 2(1+1)

### Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

### Theory

#### UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid, and population; Variety testing, release and notification systems in India and abroad.

#### UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

### UNIT III

Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder 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, pearimillet, 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*. 2<sup>nd</sup> 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.
- Poehlmatt IM & Borthakut 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.
- 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 IM & Borthalcur 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.

## M.Sc. (Ag.) Horticulture

I <sup>st</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	End Sem	Practical	Total
HORT 501	Propagation and Nursery Management for Fruit Crops	3(2+1)	20	50	30	100
HORT 502	Land Scaping and Ornamental Gardening	3(2+1)	20	50	30	100
HORT 503	Tropical and Dry Land fruit Production	3(2+1)	20	50	30	100
	Computer Application in Agriculture	2(1+1)	20	50	30	100
	<b>Total Credit</b>	<b>11</b>				
II <sup>nd</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	End Sem	Practical	Total
HORT 504	Production Technology of cool season Vegetable crops	3(2+1)	20	50	30	100
HORT 505	Subtropical and Temperate fruit production	3(2+1)	20	50	30	100
HORT 506	Production Technology of cut and loose flowers	3(2+1)	20	50	30	100
	Agricultural Statistics	3(2+1)	20	50	30	100
	<b>Total Credit</b>	<b>12</b>				
III <sup>rd</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	End Sem	Practical	Total
HORT 507	Production Technology of warm season Vegetable crops	3(2+1)	20	50	30	100
HORT 508	Protected Cultivation of Horticultural crops	2(1+1)	20	50	30	100
HORT 509	Breeding of Horticultural crops	3(2+1)	20	50	30	100
HORT 510	Post Harvest Technology for Horticultural crops	3(2+1)	20	50	30	100
	<b>Total Credit</b>	<b>11</b>				
IV <sup>th</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	End Sem	Practical	Total
HORT 591	Master Seminar	1	-	-	-	100
HORT 599	Master Research	20	-	-	-	100
	<b>Total Credit</b>	<b>21</b>				
	<b>Total Credit Hours</b>	<b>55</b>				

*less / number - 808*

# M.Sc. (Ag.) Horticulture

## I<sup>st</sup> Semester

PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 3(2+1)

**HORT 501**

**Ist Semester**

Theory UNIT I

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

UNIT II

Seed quality, treatment, packing, storage, certification, testing. Asexual propagation-rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT III

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

UNIT IV

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

UNIT V

Nursery-types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

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

grafting, hardening. Visit to TC labs and nurseries.

**I<sup>st</sup> Semester**

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

**Theory    UNIT I**

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

**UNIT II**

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

**UNIT III**

Garden plant components, arboretum, shrubbery, 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.

**I<sup>st</sup> Semester**

**HORT 503                      Tropical And Dry Land Fruit Production                      3(2+1)**

**Theory** Comercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock

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influence, planting systems, cropping systems, root zoon and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, pest and diseases management physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.

**UNIT I – Mango and Banana**

**UNIT II – Citrus and Papaya**

**UNIT III – Guava, Sapota and Jackfruit**

**UNIT IV – Pineapple, Annonas and Avocado**

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

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

### **II<sup>nd</sup> Semester**

**HORT 504**

### **PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS**

**3(2+1)**

**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, inter-cultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

**Unit I – Potato**

**Unit II – Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout.**

**Unit III – Root crops: carrot, radish, turnip and beetroot**

**Unit IV- Bulb crops: onion and garlic.**

**Unit V- Peas and broad bean, green leafy cool season vegetables.**

**Practical**

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economic; Experiments to demonstrate the role of mineral elements, plant growth substances and



herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/polyhouse.

**HORT 505** **II<sup>nd</sup> Semester** **3(2+1)**  
**SUBTROPICAL AND TEMPERAT FRUIT PRODUCTION**

**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, industrial and export potential, Agri Export Zone (AEZ) and industrial support.

**Crops**

**Unit I-** Apple, pear, quince, grapes

**Unit II-** Plums, peach, apricot, cherries, hazelnut

**Unit III-** Litchi, loquat, persimmon, kiwifruit, strawberry

**Unit IV-** Nuts-walnut, almond, pistachio, pecan

**Unit V-** Minor fruits-mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate.

**Practical**

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

**HORT 506** **II<sup>nd</sup> Semester** **3(2+1)**  
**PRODUCTION TECHNOLOGY OF CUT AND LOOSE FLOWERS**

**Theory** **UNIT I**

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

**UNIT II**

Growing environment, open cultivation of cut and loose flower, soil

requirements, field preparation, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO<sub>2</sub> on growth and flowering.

### UNIT III

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

### UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

### UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques. Post-harvest handling, Methods of delaying flower opening, prolonging self life, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

**Crops:** Rose, chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliams, as cut flower nyctanthes, jaismine, marigold, crosandra, celosia, gamphrena as loose flower.

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

### III<sup>rd</sup> Semester

## PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS

**HORT 507**  
**Theory**

**3(2+1)**

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, rconomics of crop production and seed production of :

**Unit I-** Tomato, eggplant, hot and sweet peppers

**Unit II –** Okra, beans, cowpea and clusterbean

**Unit III-** Cucurbitaceous crops

**Unit IV –** Tapioca and sweet potato

**Unit V –** Green Leafy warm season vegetables.

### **Practical**

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

### **III<sup>rd</sup> Semester**

**HORT 508      PROTECTED CULTIVATION OF HORTICULTURAL CROPS      2(1+1)**

#### **Theory      Unit I-**

Importance and scope of protected cultivation, world scenario Indian situation present and future scope. Principles used in protected cultivation, energy management, low cost structures;

#### **Unit II-**

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

#### **Unit III**

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

#### **Unit IV**

Regulation of flowering and fruiting in horticultural crops, technology for raising tomato, sweet pepper, cucumber, crops, Jherbera, rose, chrysanthemum and straw berry in protected structures training and staking in protected crops, varieties and hybrids suitable for growing in protected structures.

#### **Unit V**

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

**Practical**

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

**HORT 509**

**III<sup>rd</sup> Semester**

**BREEDING OF HORTICULTURAL CROPS**

**3(2+1)**

**Objective**

~~To educate principles and practices adopted for breeding of horticultural crops.~~

**Theory**

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

**Unit I**

Mango, papaya, banana, grape and citrus fruits.

**Unit II**

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

**Unit III**

Okra, Pea and beans.

**Unit IV**

Gourds, melons, pumpkins and squashes

**Unit V**

Cabbage, cauliflower, carrot, beetroot, radish.

**Practical**

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

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**III<sup>rd</sup> Semester**  
**HORT 510 POST HARVEST TECHNOLOGY FOR HORTICULTURAL CROPS 3(2+1)**

**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 losses horticultural crops, pre-cooling. Spoilage, microbial and biochemical physical injuries and disorders.

**Unit III**

Treatments prior to transportation, viz. grading, precoding chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage-ventilated, refrigerated, MAS, CA storage zero energy cool chamber, hypobaric storage

**Unit IV**

Packing methods and transport, principles and methods of preservation, food processing, canning preparation of fruit juices, beverages, pickles, jam, jellies, candies and tomato products.

**Unit V**

Dried and dehydrated products, nutritionally enriched products, fermented beverages, packaging technology management of processing waste, 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.

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**Department of Soil Science and Agricultural Chemistry**  
**M.Sc. (Ag.) Course content**

Code No.	Course Title	Credit Hours	Evaluation Marks			
			Theory	Practical	Mid Term	Total
SS AC 501	Soil Physics	3(2+1)	50	30	20	100
SS AC 502	Soil Fertility & Fertilizer Use	4(3+1)	50	30	20	100
SS AC 503	Soil Chemistry	3(2+1)	50	30	20	100
SSAC 504	Soil Mineralogy. Genesis, Classification & survey	3(2+1)	50	30	20	100
SS AC 505	Soil erosion and conservation	3(2+1)	50	30	20	100
SS AC 506	Soil Biology & Biochemistry	3(2+1)	50	30	20	100
SS AC 509	Soil. water and Air pollution	3(2+1)	50	30	20	100
SS AC 510	Remote Sensing & GIS Techniques for Soil & crop studies	3(2+1)	50	30	20	100
SS AC 511	Analytical Techniques & instrumental methods	2(0+2)	-	100	-	100
SS AC 513	Management of Problematic soils & waters	3(2+1)	50	30	20	100
	Computer Application in Agriculture	2(1+1)	50	30	20	100
	Agricultural Statistics	3(2+1)	50	30	20	100
SS AC 591	Masters Seminar	1	-	-	-	100
SS AC 599	Masters Research	20	-	-	-	100

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**Department of Soil Science & Agricultural Chemistry**  
**M.Sc. (Ag.) Semester wise course Distribution**

<b>Ist Semester</b>		
Code No.	Course Title	Credit Hrs.
SSAC 504	Soil Mineralogy, Genesis, Classification & survey	3(2+1)
SSAC 509	Soil, water and Air pollution	3(2+1)
SSAC 511	Analytical Techniques & instrumental methods	2(0+2)
	Computer Application in Agriculture	2(1+1)
<b>IInd Semester</b>		
SSAC 501	Soil Physics	3(2+1)
SSAC 502	Soil Fertility & Fertilizer Use	4(3+1)
SSAC 506	Soil Biology & Biochemistry	3(2+1)
	Agricultural Statistics	3(2+1)
<b>IIIrd Semester</b>		
SSAC 503	Soil Chemistry	3(2+1)
SSAC 505	Soil erosion and conservation	3(2+1)
SSAC 510	Remote Sensing & GIS Techniques for soil & crop studies	3(2+1)
SSAC 513	Management of Problematic soils & waters	3(2+1)
<b>IVth Semester</b>		
SSAC 591	Masters Seminar	1
SSAC 599	Masters Research	20
	<b>Total Cr. Hrs</b>	<b>56</b>

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## SOIL SCIENCE & AGRICULTURAL CHEMISTRY

### Course Contents

SSAC 501

SOIL PHYSICS

3Crs. (2+1)

#### 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, Poiseuille's law, Darcy's 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

### **SSAC 502 SOIL , FERTILITY AND FERTILIZER USE, 4 Crs. (3+1)**

#### **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 — fertilizers and manures; essential plant nutrients - functions and deficiency symptoms.

##### UNIT II

Soil and fertilizer nitrogen — 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 <sup>use</sup> 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 magnesium— factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

### UNIT VI

Micronutrients — 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; quantity— intensity relationships; soil test crop response correlations and response functions.

### UNIT VIII

Fertilizer use efficiency; blanket fertilizer recommendations — 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

**SSAC 503**

**SOIL CHEMISTRY**

**3Crs. (2+1)**

**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..

UNIT I

Chemical (elemental) composition of the earth's 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; clay-organic interactions.

UNIT IV

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, ionic activity measurement, thermodynamics, anion and ligand exchange - inner- sphere 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, EC<sub>e</sub>, 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, E<sub>h</sub> by the use of E<sub>h</sub>-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
- (E<sub>4</sub>/E<sub>6</sub>) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the A (E<sub>4</sub>/E<sub>6</sub>) 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 BaCl<sub>2</sub>-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

#### **SSAC 504 SOIL MINERALOGY, GENESIS, CLASSIFICATION 3 Crs. (2+1) AND SURVEY**

#### **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

Concepts and definitions of soil, soil profile; Formation and weathering of rocks and mineral, weathering sequences of minerals. Factors of soil formation, soil forming processes. -

#### UNIT IV

Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special emphasis on soil taxonomy; application of soil taxonomy.

#### UNIT V

Soil survey and its types; soil survey techniques - conventional and modern; soil series — characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping.

#### UNIT VI

Landform — soil relationship; major soil groups of India and UP.; land capability and irrigability classification; land evaluation and land use type (LUT) — 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
- Land use planning exercises using conventional and RS tools

**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 (Elm) 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 — 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**

- Determination of different soil erodibility indices, percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops

- Computation of rainfall erosivity index (EI<sub>30</sub>) using rain gauge data
- Visits to a watersheds

**SSAC 506**

**SOIL BIOLOGY AND BIOCHEMISTRY**

**3 Crs. (2+1)**

**Objective**

To teach students the basics of soil biology and biochemistry, 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; un-culturable soil biota. UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance: soil characteristics influencing growth and activity of microflora.

UNIT III

Microbial transformations of nitrogen. phosphorus. sulphur, iron and manganese in soil: biochemical composition and biodegradation of soil organic matter and crop residues. basic principles of humus formation.

UNIT IV

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V

Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI

Bibfertilizers — Definition, classification, specifications, method of production and role in crop production.

**Practical**

- Determination of soil microbial population
- Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil
  - Soil enzymes

- Measurement of important soil microbial processes such as ammonification, nitrification, N<sub>2</sub> fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

**SSAC 509**

**SOIL, WATER AND AIR POLLUTION**

**3 Crs. (2-+1)**

**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 — 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 — their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides — their classification, behavior in soil and effect on soil micro-organisms.

UNIT V

Toxic elements — 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 — 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.





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**

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of land resources
- Analysis of variability of different soil properties with classical and geo-statistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

### **SSAC 511 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 2 Crs. (0+2)**

#### **Objective**

To familiarize the students with commonly used instruments — 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, oxidation- reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

##### UNIT II

Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometry; identification of minerals by X-ray by different methods.

### UNIT III

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.

## **SSAC513 MANAGEMENT OF PROBLEM SOILS AND WATERS 3 Crs. (2+1)**

### **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 — acidic, saline and sodic soils; origin 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; characterization of brackish waters; relationship in water use and quality.

#### UNIT VI

Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

### **Practical**

- Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Determination of cations ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$ ) in ground water and soil samples
- Determination of anions ( $\text{Cl}^-$ ,  $\text{SO}_4^{--}$ ,  $\text{CO}_3$  and  $\text{HCO}_3$ ) in ground waters and soil samples
- Lime and gypsum requirements of acid and sodic soils

## COMPUTER APPLICATION IN AGRICULTURE

2(1+1)

### Theory

Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations.

e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smart phone Apps in Agriculture for farm advises, market price, post harvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

### Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix/ Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

## M.Sc. (Ag.) Agricultural Statistics

<b>STAT 501</b>	<b>Agricultural Statistics</b>	<b>3(2+1)</b>
<b>Theory</b>		
<b>Unit I</b>	Classification tabulation and graphical representation of data. Box-plot Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.	
<b>Unit II</b>	Discrete and continuous probability distribution: Binomial, Poisson, Normal distribution, 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.	
<b>Unit III</b>	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 coefficient, partial correlation coefficient, multiple correlation coefficient, rank correlation coefficient, test of significance of correlation coefficient and regression coefficients, coefficient of determination.	
<b>Unit IV</b>	Need for designing of experiments, characteristics of a good design. Basic principles of designs, randomization, replication and local control.	
<b>Unit V</b>	Uniformity trials, size and shape of plots and blocks, analysis of variance, completely randomized design, randomized block design and Latin square design, missing plot techniques, split plot design.	
<b>Unit VI</b>	Sampling techniques – Planning of survey, method of data collection, questionnaire v/s schedule, Problems of sampling frame, choice of sample of design, probability sampling, sample space, sampling design, simple random sampling, Estimation of proportion, confidence interval, Determination of sample size, stratified sampling, cluster sampling, multi state sampling, systematic sampling, ratio and regression method of estimation, Non sampling error-source and classification.	
<b>Practical</b>	On the topic listed on the theory syllabus.	