

## Course Curriculum of Ph.D. Programme Agriculture/Horticulture

- \* Agronomy
- \* Agricultural Economics
- \* Entomology
- \* Extension Education
- \* Plant Breeding & Genetics
- \* Plant Pathology
- \* Soil Science & Agricultural Chemistry
- \* Horticulture – Fruit Science
- \* Horticulture – Vegetable Science



**Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya  
Gwalior-474002 (M.P.)**

## Department of Agronomy

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

Course No.	Title	Credit
<b>Major Courses</b>		
Agron 601	Current Trends in Agronomy	3+1
Agron 604	Advances in crop growth & productivity	2+1
Agron 605	Irrigation management	2+1
<b>Minor Courses</b>		
Soils 602	Advances in soil fertility	2+0
Soils 605	Biochemistry of Soil organic matter	2+0
<b>Supporting Courses</b>		
STAT 521	Applied Regression Analysis	2+1
<b>Non-Credit Courses</b>		
PGS501	Library & Information Services	0+1
PGS502	Technical Writing & Communication Skill	0+1
PGS503	Intellectual property & Its management in Agriculture	1+0

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

<b>Major Courses</b>		
Agron 606	Advance in weed management	2+0
Agron 607	Integrated farming system and sustainable agriculture	2+0
Agron 608	Soil conservation & watershed management	2+1

<b>Minor Courses</b>		
Soils 505	Soil Erosion & conservation	2+1
Soils 606	Land use planning & watershed management	2+0

<b>Supporting Courses</b>		
STAT 531	Data Analysis Using Statistical Analysis	2+0
<b>Non-Credit Courses</b>		
PGS504	Basic Concept in Laboratory Technique	0+1
PGS505	Agricultural Research, Research Ethics and Rural development program	1+0
PGS506	Disaster Management	1+0

### **III<sup>rd</sup> –IV<sup>th</sup> Semester**

Agron. 691	Doctoral Seminar I	0+1
Agron. 692	Doctoral Seminar II	0+1
<b>IV<sup>th</sup> –VI<sup>th</sup> Semester</b>		
Agron. 699	Doctoral Research	0+45

## **AGRON 601 Current Trends in Agronomy 3+0**

### **Objective**

To acquaint the students about recent advances in agricultural production.

### **Theory**

#### **UNIT I**

Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.

#### **UNIT II**

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

#### **UNIT III**

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

#### **UNIT IV**

GIS, GPS and remote sensing for crop management, global warming, GMcrops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

#### **UNIT V**

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

### **Suggested Readings**

Agarwal RL. 1995. *Seed Technology*. Oxford & IBH.

Dahiya BS & Rai KN. 1997. *Seed Technology*. Kalyani.

Govardhan V. 2000. *Remote Sensing and Water Management in  
ommand Areas: AgroecologicalProspectives*. IBDC.

ICAR. 2006. *Hand Book of Agriculture*. ICAR.

- Narasaiah ML. 2004. *World Trade Organization & Agriculture*. Sonali Publ.
- Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.
- Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.
- Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ.

## **AGRON 604 Advances in Crop Growth and Productivity 2+1**

### **Objective**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

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

#### **UNIT III**

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial

measures; heat unit concept of crop maturity: concept and types of heat units.

## UNIT IV

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

### Practical

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

### Suggested Readings

- Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants*. Oxford and IBH.
- Delvin RM & Vitham FH. 1986. *Plant Physiology*. CBS Publ.
- Evans LT. 1975. *Crop Physiology*. Cambridge Univ. Press.
- Evans LT. 1996. *Crop Evolution, Adaptation and Yield*. Cambridge Univ. Press.
- Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands*. Oxford & IBH.

- Gupta US. 1988. *Progress in Crop Physiology*. Oxford and IBH.
- Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils*. Academic Press.
- Mukherjee S & Ghosh AK. 1996. *Plant Physiology*. Tata McGraw Hill.
- Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods*. Scientific Publishers.

## **AGRON 605 Irrigation Management 2+1**

### **Objective**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

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

#### **UNIT III**

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

#### **UNIT IV**

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

## **UNIT V**

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

## **UNIT VI**

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

### **Practical**

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

### **Suggested Readings**

- FAO. 1984. *Irrigation Practice and Water Management*. Oxford & IBH.
- Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.
- Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy*. Oxford & IBH.
- Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
- Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.
- Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.



## **AGRON 606 Advances in Weed Management 2+0**

### **Objective**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

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

#### **UNIT III**

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

#### **UNIT IV**

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

#### **UNIT V**

Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

#### **UNIT VI**

Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

### **Suggested Readings**

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

- Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley-Inter Science.
- Gupta OP. 2000. *Weed Management – Principles and Practices*. Agrobios.
- Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
- Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.
- Ross MA & CarolaLembi A. 1999. *Applied Weed Science*. 2nd Ed. Prentice Hall.
- Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*. Kalyani.
- Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

## **AGRON 607 Integrated Farming Systems for Sustainable Agriculture** **2+0**

### **Objective**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

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

#### **UNIT III**

Production potential of different components of farming systems; interaction and mechanism of different production factors; stability

indifferent systems through research; eco-physiological approaches to intercropping.

#### **UNIT IV**

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

#### **UNIT V**

New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

#### **Suggested Readings**

- Ananthkrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.
- Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.
- Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani.
- Lampin N. 1990. *Organic Farming*. Farming Press Books.
- Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.
- Panda S C. 2004. *Cropping systems and Farming Systems*. Agribios.
- Reddy M V. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
- Sharma AK. 2001. *A Hand Book of Organic Farming*. Agrobios.
- Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.
- Trivedi RN. 1993. *A Text Book of Environmental Sciences*. Anmol Publ.
- Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishtana, Bangalore.

## **AGRON 608 Soil Conservation and Watershed Management 2+1**

### **Objective**

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

### **Theory**

#### **UNIT I**

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

#### **UNIT II**

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

#### **UNIT III**

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

#### **UNIT IV**

Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

#### **UNIT V**

Drainage considerations and agronomic management; rehabilitation of abandoned *jhum*lands and measures to prevent soil erosion.

### **Practical**

- Study of different types of erosion
- Field studies of different soil conservation measures

- Run-off and soil loss measurements
- Laying out run-off plot and deciding treatments
- Identification of different grasses and trees for soil conservation
- Visit to a soil conservation research centre, demonstration and training centre

### **Suggested Readings**

- Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.
- Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.
- FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. *Soils Bull.*, Paper 57.
- Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection*. 3rd Ed. Prentice Hall.
- Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
- Murthy VVN. 1995. *Land and Water Management Engineering*. Kalyani.
- Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.
- Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

**Note : For minor courses please refer the concerned department's courses outline.**

## DEPARTMENT OF AGRIL.ECONOMICS & F. M.

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

Course No.	Title	Credits
<b>Major Courses</b>		
AG ECON 601	Advance Micro-Economic Analysis	1+1
AG ECON 602	Advance Macro –Economic Analysis	2+0
AG ECON 603	Advance Econometrics	2+1
<b>Minor Courses</b>		
EXT 601	Advances in Agriculture Extension	2+1
EXT 602	Advance Design and Techniques in Social Science Research	2+1
<b>Supporting Courses</b>		
STAT 521	Applied Regression Analysis	2+1
<b>Non-credit Courses</b>		
PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skills	0+1
PGS 503	Intellectual Property and its Management in Agriculture	1+0

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

<b>Major Courses</b>		
AG ECON 604	Advance Production Economics	2+1
AG ECON 605	Quantitative Development Policy Analysis	1+1
AG ECON 606	Advance Agricultural Marketing and Price Analysis	2+1

<b>Minor Courses</b>		
EXT 603	Advance in Training Technology	2+1
EXT 604	Organizational Development	2+1
<b>Supporting Courses</b>		
STAT 531	Data Analysis Using Statistical Packages	2+1
<b>Non-Credit Courses</b>		
PGS 504	Basic Concept in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	Disaster Management	1+0
<b>III<sup>rd</sup>-IV<sup>th</sup> Semester</b>		
AG.ECON. 691	Doctoral Seminar -I	0+1
AG. ECON. 692	Doctoral Seminar - II	0+1
<b>IV<sup>th</sup>-VI<sup>th</sup> Semester</b>		
AG. ECON. 699	Doctoral Research	0+45

## **AG ECON 601 Advanced Micro Economic Analysis**

### **Objectives**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly –Cournot model, Chamberlin model, Stackleberg solution.

#### **UNIT III**

General equilibrium theory – Conceptual overview - General equilibrium conditions with Production and Consumption. Existence,



Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.

#### **UNIT IV**

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

#### **UNIT V**

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

#### **Practical**

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

#### **Suggested Readings**

- Chiang AC. 1981. *Fundamental Methods of Mathematical Economics*. McGraw-Hill. Henderson JM & Quandt RE. *Microeconomic Theory: A Mathematical Approach*. McGraw-Hill.
- Koutsoyiannis A. 2003. *Modern Microeconomics*. The Macmillan Press.
- Kreps DM. 1990. *A Course in Microeconomic Theory*. Princeton Univ. Press.
- Silberberg E & Suen W. 2001. *The Structure of Economics-A Mathematical Analysis*. McGraw Hill.

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

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

## **AG ECON 602 Advanced Macro Economics Analysis 2+0**

### **Objective**

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

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

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

#### **UNIT III**

Stagflation and Supply side Economics - Theory of Unemployment – Phillips Curve controversy - Inflation, Productivity and distribution - Fiscal policy: Effectiveness and Problems.

#### **UNIT IV**

Social Accounting Matrix Framework - General Equilibrium Analysis - Neo classical Macro Economics - Stochastic Macro Economics.

#### **UNIT V**

BOP & Adjustment Policies - Foreign Exchange Policy - Foreign sector : Capital and Current Account - Impact of WTO on Indian Economy - Impact of IMF & IBRD on Indian Economy - Review of Macro Economic Policies in India.

## **Suggested Readings**

- Diulio EA. 2006. *Macroeconomics*. 4<sup>th</sup> Ed. Schaums' Outlines.
- Frogen RT. 1999. *Macro Economic: Theory and Policies*. 6<sup>th</sup> Ed. Prentice Hall.
- Samuelson PA & Nordhaus WD. 2004. *Economics*. McGraw-Hill.
- Shapiro E. 1989. *Macro Economic Analysis*. Galgotia Publ.

## **AG ECON 603 Advance Econometrics**

### **Objective**

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

### **Theory**

#### **UNIT I**

Review of classical regression model – review of hypothesis testing – restrictionson parameters – single equation techniques.

#### **UNIT II**

Ordinary least squares – weighted least squares - generalized least squares –method of principal components – instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests – nonspherical error terms.

#### **UNIT III**

Dummy variables - Qualitative and truncated dependent variables – limited dependent variables –LPM, probit and logit models, their multinomial extensions.

#### **UNIT IV**

Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.

#### **UNIT V**

Simultaneous equation methods –identification – estimation by indirect leastsquares 2SLS, PIML, SURE, 3SLS.

## **Practical**

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

## **Suggested Readings**

Greene WH. 2002. *Econometric Analysis*. Pearson Edu.  
Johnston J & Dinardo J. 2000. *Econometric Methods*. McGraw-Hill.  
Kelejan HH & Oates WE. 2001. *Introduction to Econometrics Principles and Applications*. Harper & Row.  
Maddala GS. 2002. *Econometrics*. McGraw Hill.

## **AG ECON 604 Advance Production Economics 2+1**

### **Objective**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance Production relations, optimality, Commonly used functional forms, nature, properties, limitations, estimation and interpretation linear, Spillman Cobb Douglas, quadratic, multiplicative (power) functional forms - Translog and transcendental functional forms-CES, production functional forms, Conceptual and empirical issues in specification, estimation and application of production functions- Analytical approaches to economic

optimum -Economic optimum, determination of economic optimum with constant and varying input and output prices- Economic optimum with production function analysis - input use behaviour.

### **UNIT III**

Decision making with multiple inputs and out puts, MRT and product relationship-cost of production and adjustment in out put prices-single input and multiple product decisions- Multi input, and multi product production decisions - Decision making with no risk Cost of wrong decisions, Cost curves – Principles and importance of duality theory - Correspondence of production, cost, and profit functions, Principles and derivation of demand and supply functions .

### **UNIT IV**

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

### **UNIT V**

Simulation and programming techniques in agricultural production- Multiple Course Objective Programming – Goal programming and Compromise programming, applications.

### **Practical**

Estimation of different forms of production functions- Optimal input and product choice from estimated functions-Derivation of demand and supply functions and estimation-Estimation of cost function and interpretations-Optimal product and input choice under multi input and output system Estimation of factor shares from empirical functions estimated Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology- Estimation of efficiency measures – Stochastic, probabilistic and deterministic frontier production functions-Risk programming MOTAD-

Quadratic programming Simulation models for agricultural production decisions. Goal programming, Weighted, lexicographic and fuzzy goal programming. Compromise programming.

### **Suggested Readings**

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

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

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

## **AG ECON 605 Quantitative Development Policy Analysis**

### **Objective**

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

### **Theory**

#### **UNIT I**

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

#### **UNIT II**

Demand analysis for policy making, Alternative approaches to demand analysis Policy implications. Supply response, Alternative approaches to measurement of supply response, Nerlovian models of supply response, Policy implications.

### **UNIT III**

Household behaviour and policy analysis – Household models.

### **UNIT IV**

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

### **UNIT V**

Social Accounting Matrices and multipliers – Computable General Equilibrium models to assess economy wide impact of policy changes.

### **Practical**

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

### **Suggested Readings**

- Chenery H & Srinivasan TN. (Eds.). 1988. *Hand book of Development Economics*. North-Holl
- Eicher KC & Staatz JM. 1998. *International Agricultural Development*. Johns Hopkins Univ. Press.
- Fischer G, Miller J & Sidney MS. (Eds.). 2007. *Handbook of Public Policy Analysis: Theory, Politics and Methods*. CRC Press.
- Frank E. 1992. *Agricultural Policies in Developing Countries*. Cambridge Univ. Press.
- Ghatak S & Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate.
- Kindleberger PC. 1977. *Economic Development*. McGraw Hill.

- Meier MG & Stigilitz JE. 2001. *Frontiers of Development Economics- the Future Perspective*. Oxford Univ. Press.
- Sadoulet E & de Janvry A. 1995. *Quantitative Development Policy Analysis*. London: John Hopkins Univ. Press.
- Shoven Neck R, Christian R & Mooslechner P. (Eds.). 2008. *Quantitative Economic Policy Essays in Honour of Andrew Hughes Hallett*.

## **AG ECON 606 Advance Agricultural Marketing and Price Analysis**

### **Objective**

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

### **Theory**

#### **UNIT I**

Importance of market analysis in the agricultural system, types of marketing advantages and disadvantages - quantitative estimation, the distinguishing characteristics and role of agricultural prices, data sources for agricultural products and prices - softwares used in market analysis.

#### **UNIT II**

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

#### **UNIT III**

Multi market estimation, supply response models. Market integration and price transmission - supply / value chain management. GAP analysis. Current trends in information in the changing agri food system.



#### **UNIT IV**

Agricultural commodity marketing - spot and futures- marketing of derivatives-speculation, hedging, swap, arbitrage etc. commodity exchanges - price discovery and risk management in commodity markets-Regulatory mechanism of futures trading.

#### **UNIT V**

Lag operators and difference equations; stationary and stochastic processes; UNIT roots and cointegration; conditional heteroscedasticity:ARCH and GARCH models - forecast evaluation; methods of forecasting. price indices and econometric estimation and simulation.

#### **Practical**

Estimation of demand/ supply forecasting, supply chain / value chain analysis for different commodities - Commodity models- multi market estimation- time series analysis - market integration studies- pricediscovery price volatility estimation - commodity price forecasting using econometric softwares.

#### **Suggested Readings**

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

**Note :** For minor courses please refer the concerned department's courses outline

## DEPARTMENT OF ENTOMOLOGY

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

Course No.	Title	Credit
<b>Major Courses</b>		
ENT 603	Advanced Insect Physiology	2+0
ENT 605	Insect Behaviour	1+1
ENT 606	Recent Trends in Biological Control	1+1
ENT 607	Advance Insecticide Toxicology	2+1
<b>Minor Courses</b>		
Pl. Path 603	Advanced Bacteriology	2+1
Pl. Path 604	Molecular Basis of Host Pathogen Interaction	1+0
<b>Supporting Courses</b>		
STAT 521	Applied Regression Analysis	2+0
<b>Non-Credit Courses</b>		
PGS501	Library & Information Services	0+1
PGS502	Technical Writing & Communication Skill	0+1
PGS503	Intellectual property & Its management in Agriculture	1+0

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

ENT 608	Advanced Host Plant resistance	1+1
ENT 611	Molecular approaches in Entomological Research	1+1
ENT 612	Advanced Integrated Pest Management	2+0

<b>Minor Courses</b>		
Pl. Path 602	Advanced Virology	2+1
Pl. Path 605	Principles & Procedures of Certification	1+0
<b>Supporting Courses</b>		
STAT 531	Data Analysis Using Statistical Analysis	2+0
<b>Non-Credit Courses</b>		
PGS504	Basic Concept in Laboratory Technique	0+1
PGS505	Agricultural Research, Research Ethics and Rural development program	1+0
PGS506	Disaster Management	1+0

### **III<sup>rd</sup>-IV<sup>th</sup> Semester**

ENT 691	Doctoral Seminar I	0+1
ENT 692	Doctoral Seminar II	0+1

### **IV<sup>th</sup> –VI<sup>th</sup> Semester**

ENT 699	Doctoral Research	0+45
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## **ENT 603 Advance Insect Physiology 2+0**

### **Objective**

To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

### **Theory**

#### **Unit I**

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

#### **Unit II**

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

#### **Unit III**

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

#### **Unit IV**

Endocrine system and insect hormones, physiology of insect growth and development metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

### **Suggested Readings**

Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. IXIII. Pergamon Press, Oxford, New York.

Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.

## **ENT 605 Insect Behaviour 1+1**

### **Objective**

To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behaviour in insects.

### **Theory**

#### **Unit I**

Defining Behaviour- Concept of Umwelt, instinct, fixed action patterns, imprinting, complex behaviour, induced behaviour, learnt behaviour and motivation. History of Ethology development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

#### **Unit II**

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

#### **Unit III**

Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behaviour.

#### **Unit IV**

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

## Practical

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honeybees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

## Suggested Readings

- Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford & IBH, New Delhi.
- Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ., Jodhpur.
- Bernays EA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, London.
- Brown LB. 1999. *The Experimental Analysis of Insect Behaviour*. Springer, Berlin.
- Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology*. 3rd Ed. Chapman & Hall, London.
- Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press, USA.
- Mathews RW & Mathews JR. 1978. *Insect Behaviour*. A Wiley- Inter Science Publ. John Wiley & Sons, New York.

## ENT 606 Recent Trends in Biological Control 1+1

### Objective

To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agroecosystems.

## **Theory**

### **Unit I**

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.

### **Unit II**

Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

### **Unit III**

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, largescale production of biocontrol agents, bankable project preparation.

### **Unit IV**

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

## **Practical**

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

## **Suggested Readings**

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites*. Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression*. Springer Verlag, Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds*. Chapman & Hall, London.

Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control*. Academic Press, London.

## **ENT 607 Advance Insecticide Toxicology 2+1**

### **Objective**

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

### **Theory**

#### **Unit I**

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

#### **Unit II**

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural –activity relationships; advances in metabolism of insecticides.

#### **Unit III**

Joint action of insecticides; activation, synergism and potentiation.

#### **Unit IV**

Problems associated with pesticide use in agriculture: pesticide resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

#### **Unit V**

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.



## **Practical**

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

## **Suggested Readings**

- Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides*. CABI, London.
- Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.
- Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Toxicology*. Academic Press, New York.
- Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action*. Narosa Publ. House, New Delhi.
- Matsumura F. 1985. *Toxicology of Insecticides*. Plenum Press, New York.
- O' Brien RD. 1974. *Insecticides Action and Metabolism*. Academic Press, New York.
- Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment*. Narosa Publ. House, New Delhi.
- Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture*. Lewis Publ., New York.

## **ENT 608 Advanced Host Plant Resistance 1+1**

### **Objective**

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

### **Theory**

#### **Unit I**

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors.

## **Unit II**

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

## **Unit III**

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding.

## **Unit IV**

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

## **Practical**

Understanding mechanisms of resistance for orientation, feeding, oviposition *etc.*, allelochemical bases of insect resistance; macroculturing of test insects like aphids, leaf/planthoppers, mites and stored grain pests; field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

## **Suggested Readings**

- Panda N. 1979. *Principles of Host Plant Resistance to Insects*. Allenheld, Osum & Co., New York.
- Rosenthal GA & Janzen DH. (Eds.). 1979. *Herbivores – their Interactions with Secondary Plant Metabolites*. Vol. I, II. Academic Press, New York.
- Sadasivam S & Thayumanavan B. 2003. *Molecular Host Plant Resistance to Pests*. Marcel Dekker, New York.
- Smith CM, Khan ZR & Pathak MD. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida.

## **ENT 611 Molecular Approaches in Entomological Research 1+1**

### **Objective**

To familiarize the students with DNA recombinant technology, marker genes, transgenic plants, biotechnology in sericulture and apiculture.

### **Theory**

#### **Unit I**

Introduction to molecular biology; techniques used in molecular biology.

#### **Unit II**

DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

#### **Unit III**

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, neuropeptides. Transgenic plants for pest resistance and diseases.

#### **Unit IV**

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

#### **Unit V**

DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

## **Practical**

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gelelectrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

## **Suggested Readings**

- Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotechnology*. 1st Ed., Kalyani Publ., New Delhi.
- Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science*. Plenum Press, New York.
- Oakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.
- Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Lewis Publ., North Carolina.
- Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., NewDelhi.
- Singh BD. 2008. *Biotechnology (Expanding Horizons)*.Kalyani Publ., New Delhi.
- Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

## **ENT 612 AdvancedIntegrated Pest Management 2+0**

### **Objective**

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

## **Theory**

### **Unit I**

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

### **Unit II**

Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

### **Unit III**

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real time situations.

### **Unit IV**

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

## **Suggested Readings**

- Dhaliwal GS & Arora R. 2003. *Integrated Pest Management– Concepts and Approaches*. Kalyani Publ., New Delhi.
- Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
- Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management*. Springer, Berlin.
- Koul & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management*. CABI, London.
- Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management-Potential, Constraints and Challenges*. CABI, London.

- Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena*. CABI, London.
- Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management*. John Wiley & Sons, New York.
- Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management*. Prentice Hall, New Delhi.
- Pedigo RL. 1996. *Entomology and Pest Management*. Prentice Hall, New Delhi.
- Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products*. Marcel Dekker, New York.

**Note : For minor courses please refer the concerned department's courses outline.**

## DEPARTMENT OF EXTENSION EDUCATION

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

Course No.	Title	Credit
<b>Major Courses</b>		
EXT 601	Advances in Agriculture Extension	2+1
EXT 602	Advanced Designs and Techniques in Social Science Research	2+1
EXT 607	Advanced Management Technique	2+1
<b>Minor Courses</b>		
AG ECON 601	Advanced Micro-Economic Analysis	1+1
AG ECON 602	Advanced Macro-Economic Analysis	2+0
<b>Supporting Courses</b>		
STAT 521	Applied Regression Analysis	2+1
<b>Non-Credit Courses</b>		
PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skill	0+1
PGS 503	Intellectual Property and Its Management	1+0

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

<b>Major Courses</b>		
EXT 603	Advances in Training Technology	2+1
EXT 604	Organizational Development	2+1
EXT 609	Transfer of Technology in Agriculture	2+1
<b>Minor Courses</b>		
AG ECON 604	Advanced Production Economics	2+1
AG ECON 606	Advanced Agricultural Marketing and Price Analysis	2+1

<b>Supporting Course</b>		
STAT 531	Data Analysis Using Statistical Analysis	2+1
<b>Non-Credit Courses</b>		
PGS 504	Basic Concept of Laboratory Technique	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	Disaster Management	1+0

### **III<sup>rd</sup> –IV<sup>th</sup> Semester**

EXT 691	Doctoral Seminar – I	0+1
EXT 692	Doctoral Seminar - II	0+1

### **IV<sup>th</sup> –VI<sup>th</sup> Semester**

EXT 699	Doctoral Research	0+45
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## **EXT 601 Advances in Agricultural Extension 2+1**

### **UNIT I**

Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

### **UNIT II**

Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact of agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension - Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership, Stakeholder's analysis in Extension, Main streaming gender in Extension - Issues and Prospects.

### **UNIT III**

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

### **UNIT IV**

Extension and contemporary issues: Extension and issues related to rural poverty, Privatization of Extension, Intellectual Property Rights (IPRs). Extension Reforms in India - Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups, Organization innovations in Extension - ATIC, IVLP, Kisan Call 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, Analysis of ATMA and SREP, Practicing bottom up planning. Visit to Public-Private –Farmer partnership, Learnings from Food and Nutritional Security and bio-diversity Projects and Programmes.

## Suggested Readings

- Bagchi J. 2007. *Agriculture and WTO Opportunity for India*. Sanskruti.
- Chambers R, Pacy A & Thrupp LA. 1989. *Farmers First*. Intermediate Technology Publ.
- Crouch BR & Chamala S. 1981. *Extension Education and Rural Development*. Macmillan.
- John KC, Sharma DK, Rajan CS & Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems*. MANAGE, Concept Publ.Co.
- Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.
- Narasaiah ML. 2005. *Agricultural Development and World Trade Organization*. Discovery Publ.
- Talwar S. 2007. *WTO Intellectual Property Rights*. Serials Publ.
- Van den Ban BW & Hawkins BS. 1998. *Agricultural Extension*. S.K. Jain Publ.
- Venkaiah S. 2001. *New Dimensions of Extension Education*. Anmol Publ.

## EXT 602 Advanced Designs and Techniques in Social Science Research 2+1

### UNIT I

Scaling technique - meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Reliability and Validity of

Scales, Sociometrics, content analysis, case studies, Q-sort techniques, Semantic different technique.

## UNIT II

Projective and Semi projective techniques, Critical incident techniques, Computer packages for analysis - usage in Extension Research, Knowledge scale measurement, Participatory tools and techniques in behaviour Research – Data collection and Evaluation, Impact analysis, e-data collection and information analysis.

### Practical

Practice in constructing a scale and use of scale in various situations. Reliability and validity of the scales developed, Application of Semi Projective and Projective techniques, Content analysis, case studies, practicing participatory tools and techniques. Hands on experience on Computer Preparation and Data Collection instruments, review of previous studies.

### Suggested Readings

- Burns RB. 2000. *Introduction to Research Methods*. Sage Publ.
- Chandrakandan K & Karthikeyan C. 2004. *Behavioral Research Methodology*. Classical Publ.
- Daivadeenam P. 2002. *Research Methodology in Extension Education*. Agro-TechPubl. Academy.
- Kerlinger N Fred. 2002. *Foundations of Behavioural Research*. Surjeet Publ.
- Kothari CR. 2000. *Research Methodology Methods & Techniques*. 2nd Ed. Wishwa Prakasham.
- Ray GL & Mondal S. 1999. *Research Methods in Social Science and Extension Education*. Naya Prokash.
- Roger L & Domino WSK. 1980. *Research Methods*. Prentice Hall.
- Sadhu AM & Singh A. 2003. *Research Methodology in Social Science*. Himalaya Publ. House.
- Sarantakos S. 1998. *Social Research*. 2nd Ed. Macmillan.

- Sinha SC & Dhiman AK. 2002. *Research Methodology*. ESS Publ.
- Verma RK & Verma G. 2002. *Research Methodology*. Commonwealth Publ.
- Walizer MH & Panl L. 2002. *Research Methods & Analysis; Searching for Relationships*. Wiemil Harper & Row.
- Wilkinson TS & Bhandarkar PL. 2002. *Methodology and Techniques of Social Research*. Himalaya Publ. House.

## **EXT 607 Advanced Management Techniques 2+1**

### **Theory**

#### **UNIT I**

Management Information System (MIS): Basic concepts, types of information needed at various levels, design of MIS in an agricultural extension organization, Scope for computerization, system alternatives and Evaluation, Implementation, operation and maintenance of the system.

#### **UNIT II**

Management by Course Objective (MBO): Elements of the MBO system, The Process of MBO. Making MBO effective, Evaluation of the MBO system - strengths and weaknesses, Transactional Analysis (TA): Ego states, transactions, inter relationships, strokes, stamps.

#### **UNIT III**

Managing Organizational Stress: Sources of stress in organization, effect of stress. Coping mechanisms and managing stress, Stress management, Team Building Process: Types of teams, Steps in teamwork, Facilitators and barriers to effective relationships, nature of prejudice, tips in reducing interpersonal conflicts, intergroup conflict, resolving techniques, Conflict management, tips in reducing interpersonal conflicts.

#### **UNIT IV**

Decision Support Systems (DSSs): Basic information about Artificial Intelligence(AI) Expert System (ESs), their future applications in

extension system. Forecasting techniques - time series analysis and Delphi, decision making and talent management PERT, CPM Techniques and time management.

### **Practical**

Managements Information system, in research & development organizations, Study of Management by Course Objective in an organization, Transactional Analysis, exercises on Team building process, coping skills with organizational stress, exercises on Decision Support Systems (DSSs), Practical exercise on forecasting techniques, Visit to Management organizations.

### **Suggested Readings**

- Chaudhary AK. 1999. *Encyclopedia of Management Information System*. Vols. I, II. Anmol Publ.
- Hari Gopal K. 1995. *Conflict Management - Managing Interpersonal Conflict*. Oxford & IBH.
- James O'Brien 1999. *Management Information System*. Tata McGraw-Hill.
- Koontz H & Welhrich H. 2004. *Essentials of Management*. 5th Ed. Tata McGraw-Hill.
- Lauden & Laudon 2003. *Management Information System*. Pearson Edu.
- Maheswari BL. 1980. *Organizational Decision Styles & Orgul Effectiveness*. Vikas Publ.
- McGrath SJEH. 2007. *Basic Management Skills for All*. 7th Ed. Prentice Hall of India.
- West JD & Leevy FK. 1998. *A Management Guide to PERT / CPM with GERT /PDM / DCPM and Other Networks*. Prentice Hall of India.

## **EXT 603 Advances in Training Technology 2+1**

### **Theory**

#### **UNIT I**

Paradigm shift in training - learning scenario, Training Approaches – Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, harmonizing training needs, Course Objective, content and methods.

#### **UNIT II**

Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).

#### **UNIT III**

Recent Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools:

TAT, Inventories, Cases, etc.

#### **UNIT IV**

Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainer's roles and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.

### **Practical**

Techniques of participatory training need assessment. Formulation of Course Objective, design of training programmes, Simulation exercises, Participatory training methods - Role Play & Brainstorming, Group discussion and Counseling and Conducting experiential learning sessions, Training evaluation - Techniques of Knowledge, Skill &

Attitude evaluation. Visit to training institutions and study of training technologies followed.

### **Suggested Readings**

- Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.
- Alan B & Calardy 2004. *Five Case Studies in Management Training*. Jaico Publ.
- Kumar A. 2000. *Management Training Process*. Anmol Publ.
- Leslie Rae. 1998. *Techniques of Training*. Jaico Publ.
- Lynton RP & Pareek U. 1999. *Training for Development*. 2nd Ed. Vistar Publ.
- Reid MA. 1997. *Training Interventions, Managing Employee Development*. Jaico.Publ.
- Samanta RK. 1993. *Training Methods for Management and Development*. M.D.Publ.
- Sethy ED. 2003. *A Practical Hand Book on Training*. Anmol Publ.

## **EXT 604 Organizational Development 2+1**

### **Theory**

#### **UNIT I**

Introduction to organizations: Concept and Characteristics of organizations, Organizational Behaviour - Context and concept - levels of organizations – formal and informal organizations, Theories of organizations: Nature of organizational theory - classical theories - features of Bureaucracy - administrative theory and Scientific management - Neo-classical theories - the human relations movement - modern theory.

#### **UNIT II**

Systems approach to study organization needs and motives - Attitude, values and ethical behaviour - alienation and work - work motivation - communication and interpersonal behaviour - organization communication - leadership behaviour - decision making, problem

solving techniques - organizational climate – change proneness and resistance to change, Organizational change, Organizational structure - Process in organizing - Dimension of Motivation Climate.

### **UNIT III**

Departmentation - Span of Management - Delegation of authority – Centralization and decentralization - line and staff organization - functional organization - divisionalisation - Project organization - Matrix organization - free form organization - top management structure.

### **UNIT IV**

Individual behaviour in organization, Fundamentals of Human relations and Organizational behaviour, Groups and teams - Organizational culture and performance, Dynamics of Organization behaviour - leadership conflict situation and inter group behavior- Organizational Development - Factors effecting organization effectiveness, Creativity, leadership, motivation and organization development.

### **Practical**

Analysis of organization in terms of process - attitudes and values, motivation, leadership, Simulation exercises on problem-solving - Study of organizational climate in different organizations. Study of organizational structure of development departments, Study of departmentalization, span of control delegation of authority, decisions making patterns, Study of individual and group behaviour at work in an organization, Conflicts and their management in an organization, Comparative study of functional and non-functional organizations and drawing factors for organizational effectiveness.

### **Suggested Readings**

- Ancona, Kochaw, Scully, Van Maanen, Westney 1999. *Organizational Behaviour and Processes*. South Western College Publ., New York.
- Banerjee M. 1984. *Organizational Behaviour*. Allied Publ.
- Deka GC. 1999. *Organizational Behaviour - A Conceptual Applicational Approach*. Kanishka Publ.



- Dwivedi RS. 2006. *Human Relations and Organization Behaviour- A Global Perspective*. 5th Ed. Macmillan.
- Kumar A. 2000. *Organizational Behaviour Theory and Practice*. Anmol Publ.
- Luthans F. 1998. *Organizational Behavior*. Tata McGraw Hill.
- Luthans F. 2001. *Organizational Behaviour*. McGraw Hill.
- Newstrom JW & Davis K. 1997. *Human Behaviour at Work*. Tata McGraw Hill.
- Robbins SP. 2007. *Organizational Behaviour*. Prentice Hall.
- Shaun T & Jackson T. 2003. *The Essence of Organizational Behaviour*. Practice Hall of India.
- Stephen RR. 1999. *Organizational Behaviour*. 5th Ed. Practice Hall of India.

## **EXT 609 Transfer of Technology in Agriculture 2+1**

### **Theory**

#### **UNIT I**

Technology - Meaning and Concepts - Appropriate technology, transfer of technology - meaning and concepts, Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) - Knowledge Consuming System (KCS) - Input Supplying Agencies System (ISAS).

#### **UNIT II**

Appropriateness of communication media in the system of technology transfer, New communication strategy for transfer and adoption of Agricultural technology, Extension training in transfer of technology.

#### **UNIT III**

Analysis, Constraints in Transfer of Technology, agencies or departments involved in TOT, Extension professional in TOT, Attributes of Technology and its Relation in TOT process. TOT to resource poor farmers, Role of Key communicators or local leaders in TOT, Private and Public partnership in TOT.

## Practical

Analysis of Transferred technology, Analysis of knowledge generation and consuming systems, Formulation of communication strategies, Study of attributes of selected fast spreading technologies and slow technologies, study of constraints in TOT, visit to TOT centers of ICAR and SAU, Identification of key communicators, Case studies of Public-Private Partnerships, Visits to the print and electronic media centers to study their role in TOT.

## Suggested Readings

- Chaturvedi TN. 1982. *Transfer of Technology among Developing Countries; Needfor Strengthening Cooperation*. Gitanjali Publ. House.
- Dunn DD. 1978. *Appropriate Technology with a Human Face*. Macmillan Press.
- Kapoor SK, Roy PB & Roy AK. 1980. *Role of Information Centers in Technology Transfer*. IASLIC, Kolakata.
- Lekhi RK. 1984. *Technological Revolution in Agriculture*. Classical Publ. Co.
- Singh SN. 1991. *Transfer of Technology to Small Farmers. An Analysis of Constraints and Experience*. Concept Publ. Co.
- Wallender HW. 1980. *Technology Transfer of Management in the Developing Countries*. Ballinger Publ. Co., Cambridge.

**Note: For minor courses please refer the concerned department's courses outline.**

## DEPARTMENT OF PLANT BREEDING & GENETICS

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

Course No.	Title	Credits
<b>Major Courses</b>		
GP 601	Plant Genetics resources and Pre-Breeding	2+0
GP 604	Molecular and chromosomal manipulation for crop Breeding	2+0
GP 605	Advances in plant Breeding Systems	2+0
<b>Minor Courses</b>		
ENT 606	Recent trends in Biological Control	1+1
ENT 608	Advance Host Plant resistance	1+1
<b>Supporting Courses</b>		
STAT 521	Applied regression Analysis	2+1
<b>Non-Credit Courses</b>		
PGS501	Library & Information Services	0+1
PGS502	Technical Writing & Communication Skill	0+1
PGS503	Intellectual property & Its management in Agriculture	1+0

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

<b>Major Courses</b>		
GP 603	Genomics in Plant Breeding	2+1
GP 602	Advanced Biometrical & Quantitative Genetics	2+1
GP 608	Advances in Breeding of major field crops	3+0

<b>Minor Courses</b>		
ENT 611	Molecular approaches in Entomological research	1+1
ENT 612	Advanced Integrated pest management	2+0
<b>Supporting Courses</b>		
STAT 531	Data analysis using statistical packages	2+1
<b>Non-Credit Courses</b>		
PGS504(NC)	Basic Concept in Laboratory Technique	0+1
PGS505(NC)	Agricultural Research, Research Ethics and Rural development program	1+0
PGS506(NC)	Disaster Management	1+0

### **III<sup>rd</sup> – IV<sup>th</sup> Semester**

GP691	Doctoral Seminar – I	0+1
GP692	Doctoral Seminar - II	0+1

### **IV<sup>th</sup> – VI<sup>th</sup> Semester**

GP699	Doctoral Research	0+45
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## **GP 601 Plant Genetic Resources and Pre-Breeding 2+0**

### **Objective**

To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.

### **Theory**

#### **UNIT I**

Historical perspectives and need for PGR conservation; Importance of plant genetic resources; Taxonomical classification of cultivated plants; Genepool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; Basic genetic resources and transgenes.

#### **UNIT II**

Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.

#### **UNIT III**

Germplasm conservation- *in situ*, *ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources.

#### **UNIT IV**

PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.

#### **UNIT V**

Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre Mendelian era and

21<sup>st</sup> century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

#### **UNIT VI**

Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.

#### **UNIT VII**

Post-genomic tools for genetic enhancement of germplasm; Prebreeding through chromosome manipulation; Application of biotechnology for Genetic enhancement-Achievements.

#### **UNIT VIII**

Utilization of genetic resources, concept of core and mini-core collections, genetic enhancement/Prebreeding for crop improvement including hybrid development.

#### **Suggested Readings**

- Frankel OH & Bennett E. 1970. *Genetic Resources in Plants – their Exploration and Conservation*. Blackwell.
- Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. *Plant Germplasm Collecting: Principles and Procedures*. NBPGR, New Delhi.
- Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.
- Paroda RS & Arora RK. 1991. *Plant Genetic Resources, Conservation and Management. Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.
- Puzone L & Hazekamp TH. 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

Singh RJ & Jauhar PP. 2005. *Genetic Resources, Chromosomal Engineering and Crop Improvement*. Vol. I. *Grain Legumes*, Vol. II. *Cereals*. CRC Press, Taylor & Francis Group, USA.

## **GP 602 Advanced Biometrical and Quantitative Genetics 2+1**

### **Objective**

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

### **Theory**

#### **UNIT I**

Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes; Designs and Systems; Selection of stable genotypes.

#### **UNIT II**

Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Principal Component Analysis.

#### **UNIT III**

Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model -Biplots and mapping genotypes.

#### **UNIT IV**

Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance – Construction of saturated linkage maps, concept of framework map development; QTL mapping- Strategies for QTL mapping - desired populations, statistical methods; Marker Assisted Selection (MAS) -

Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

### **Practical**

Working out efficiency of selection methods in different populations and interpretation Biparental mating use of softwares in analysis and result interpretation Triallel analysis use of softwares in analysis and result interpretation Quadriallel analysis use of softwares in analysis and result interpretation Triple Test Cross (TTC) use of softwares in analysis and result interpretation Advanced biometrical models for combining ability analysis Selection of stable genotypes using stability analysis; Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model Principal Component Analysis model - Additive and multiplicative model Shifted multiplicative model - Analysis and selection of genotypes Methods and steps to select the best model - Selection systems Biplots and mapping genotypes. Construction of linkage maps and QTL mapping Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

### **Suggested Readings**

- Bos I & P Caligari. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.
- Falconer DS & Mackay J. 1996. *Introduction to Quantitative Genetics*. Longman.
- Mather K & Jinks L. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
- Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.
- Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.
- Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.



Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

## **GP 603 Genomics in Plant Breeding 2+1**

### **Objective**

To impart practical skills in advanced molecular techniques in genome mapping structural/functional genomics and development of transgenic crops.

### **Theory**

#### **UNIT I**

Introduction to the plant genome- Plant nuclear genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.

#### **UNIT II**

Establishment of plant genome mapping projects Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Map based cloning of plant genes.

#### **UNIT III**

Regulation of Plant gene expression - Functional genomics – Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.

#### **UNIT IV**

Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics–Genome Comparison Techniques- Classical and advanced approaches.

## UNIT V

Detection of Single Nucleotide Polymorphism; TILLING and Eco-TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping.

## UNIT VI

Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.

### Practical

Chromosome analysis in major field crops - Fluorescence *in situ* hybridization Comparative genomic hybridization Comparative analysis of plant genomes using molecular markers – Genetic map construction using molecular markers – Mapping major genes using molecular markers – QTL mapping in plants – Comparison across mapping populations – Understanding the need genetic algorithms in QTL mapping – Plant Genome Databases – Computational tools to explore plant genome databases Comparative genomics Comparison of genome sequences using tools of bioinformatics- Advanced genomic technologies: TILLING and Eco-TILLING – DNA Array Technology Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.

### Suggested Readings

- Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. Wiley Interscience.
- Brown TA. 2002. *Genomes*. Wiley-LISS.
- Caetano-Anolles G & Gresshoff PM. 1998. *DNA Markers: Protocols, Applications and Overviews*. Wiley-VCH.
- Cantor CR & Smith CL (2004). *Genomics*. Wiley, New York.
- Galas DJ & McCormack SJ. 2002. *Genomic Technologies: Present and Future*. Calster Academic Press.

- Jordan BR. 2001. *DNA Microarrays: Gene Expression Applications*. Springer-Verlag.
- Liu BH. 1997. *Statistical Genomics: Linkage, Mapping and QTL Analysis*. CRS Press.
- Lynch M & Walsh B. 1998. *Genetics and Analysis of Quantitative Traits*. Sinauer Associates.
- Mount DW. 2001. *Bioinformatics. Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
- Palzkill T. 2002. *Proteomics*. Kluwer.
- Paterson AH. 1996. *Genome Mapping in Plants*. Academic Press.
- Pennington SR & Dunn MJ. 2002. *Proteomics: From Protein Sequence to Function*. Viva Books.
- Rampal JB. 2001. *DNA Arrays: Methods and Protocols*. Humana Press.

## **GP 604 Molecular and Chromosomal Manipulations for Crop Breeding 2+0**

### **Objective**

This course focuses on the advanced techniques in analyzing chromosome structure and manipulations for genome analysis in crop species.

### **Theory**

#### **UNIT I**

Organization and structure of genome Genome size Organization of organellar genomes Nuclear DNA organization Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content C value paradox; Sequence complexity Introns and Exons Repetitive sequences – Role of repetitive sequence.

#### **UNIT II**

Karyotyping Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of

genes/genomic segments; Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.

### **UNIT III**

Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchange genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes- linked marker methods; Duplication - production and use; Inversions and location of genes; B/A chromosome translocations and gene location.

### **UNIT IV**

Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping.

### **UNIT V**

Barriers to inter specific and intergeneric hybridization Behaviour of interspecific and intergeneric crosses; Totipotency of cells Morphogenesis: *in vivo* and *in vitro* – Meristem culture anther and pollen culture – ovule, ovary, embryo and endosperm culture protoplast isolation and culture – protoplast fusion, Different pathways of *in vitro* morphogenesis organogenesis and somatic embryogenesis; *in vitro* mutant/somaclone selection for biotic and abiotic stresses.

### **Suggested Readings**

- Clark MS & Wall WJ. 1996. *Chromosomes: The Complex Code*. Chapman & Hall.
- Conger BV. (Ed.). 1981. *Cloning Agricultural Plants via in vitro Techniques*. CRC Press.
- Constabel F & Vasil IK. (Eds.). 1988. *Cell Culture and Somatic Cell Genetics of Plants*. Vol. V. *Cell Culture and Phytochemicals in Plant Cell Cultures*. Academic Press.

Lal R & Lal S. (Eds.). 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.

Mantel SH & Smith H. 1983. *Plant Biotechnology*. Cambridge University Press.

Sen SK & Giles KL. (Eds.). 1983. *Plant Cell Culture in Crop Improvement*. Plenum Press.

## **GP 605 Advances in Plant Breeding Systems 2+0**

### **Objective**

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

### **Theory**

#### **UNIT I**

Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

#### **UNIT II**

Self- incompatibility and sterility Types of self incompatibility: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.

### **UNIT III**

Population formation by hybridization Types of populations Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.

### **UNIT IV**

Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross.

### **UNIT V**

Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications – Mass selection: grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection), Recurrent selection for general combining ability (GCA), Concepts and utilization - Recurrent selection for specific combining ability (SCA) –usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

### **UNIT VI**

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatibility and sterility in plant breeding – case studies; Fertility restoration in male sterile lines and restorer diversification programmes, Conversion of agronomically ideal genotypes into male steriles, Concepts and breeding strategies; Case studies -Generating new cytonuclear interaction system for diversification of male steriles, Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic

Male Sterility (EGMS), Types of EGMS; Influence on their expression, genetic studies; Photo and thermosensitive genetic male sterility and its use in heterosis breeding, Temperature sensitive genetic male sterility and its use heterosis breeding, Apomixis and its use in heterosis breeding. Incongruity, Factors influencing incongruity - Methods to overcome incongruity mechanisms.

### **Suggested Readings**

- Agarwal RL. 1996. *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford & IBH.
- Allard RW. 1966. *Principles of Plant Breeding*. John Wiley & Sons.
- Briggs FN & Knowles PF. 1967. *Introduction to Plant Breeding*. Reinhold.
- Fehr WR. 1987. *Principles of Cultivar Development: Theory and Technique*. Vol I. Macmillan.
- Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
- Mandal AK, Ganguli PK & Banerji SP. 1995. *Advances in Plant Breeding*. Vol.I, II.CBS.
- Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.
- Sharma JR. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
- Simmonds NW. 1979. *Principles of Crop Improvement*. Longman.
- Singh BD. 1997. *Plant Breeding: Principles and Methods*. 5th Ed., Kalyani.
- Singh P. 1996. *Essentials of Plant Breeding*. Kalyani.
- Welsh JR. 1981. *Fundamentals of Plant Genetic and Breeding*. John Wiley.

## **GP 608 Advances in Breeding of Major Field Crops 3+0**

### **Objective**

To provide insight into recent advances in improvement of cereals, millets and non cereal crops using conventional and modern biotechnological approaches.

### **Theory**

#### **UNIT I**

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.

#### **UNIT II**

Breeding objectives in rice, wheat, maize, pearlmillet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.

#### **UNIT III**

Breeding for value addition and resistance to abiotic and biotic stresses.

#### **UNIT IV**

Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

#### **UNIT V**

National and International accomplishments in genetic improvement of major field crops and their seed production.

### **Suggested Readings**

Chopra VL. 2001. *Breeding Field Crops - Theory and Practice*. Oxford & IBH.



- Davis DD. 1978. *Hybrid Cotton Specific Problems and Potentials*. Adv. Agron. 30: 129-157.
- Heyne EG. 1987. *Wheat and Wheat Improvement*. 2nd Ed. ASA, CSSA, SSSA Inc Publ.
- Khairwal, IS, Rai KN & Harinaryanan H. (Eds.). 1999. *Pearl Millet Breeding*. Oxford & IBH.
- Khairwal I, Ram C & Chhabra AK. 1990. *Pearl Millet Seed Production and Technology*. Manohar Publ.
- Nagarajan S, Singh G & Tyagi BS. 1998. *Wheat Research Needs Beyond 2000 AD*. Narosa.
- Nanda JS. 2000. *Rice Breeding and Genetics - Research Priorities and Challenges*. Oxford & IBH.
- Rao VS, Singh G & Misra SC. 2004. *Wheat: Technologies for Warmer Areas*. Annamaya Publ.
- Reynolds MP, Rajaram S, McNab A. 1996. *Increasing Yield Potential in Wheat: Breaking the Barriers*. Proc. Workshop held in Ciudad, Obregon, Sonora, Mexico.
- Seth BL, Sikka SM, Dastur RH, Maheshwari P, Rangaswamy NS & Josi AB. 1960. *Cotton in India – A Monograph*. Vol. I. ICAR.
- Singh BD. 2006. *Plant Breeding - Principles and Methods*. Kalyani.
- Singh P & Singh S. 1998. *Heterosis Breeding in Cotton*. Kalyani.
- Singh P. 1998. *Cotton Breeding*. Kalyani.
- Singh S & Singh P. 2006. *Trends in Wheat Breeding*. Kalyani Publ.

**Note : For minor courses please refer the concerned department's courses outline.**

## DEPARTMENT OF PLANT PATHOLOGY

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

Course No.	Title	Credit
<b>Major Courses</b>		
Pl. Path 601	Advanced Mycology	2+1
Pl. Path 602	Advanced Virology	2+1
Pl. Path 603	Advanced Bacteriology	2+1
<b>Minor Courses</b>		
ENT 606	Recent Trends in Biological Control	1+1
ENT 607	Advanced Insecticide Toxicology	2+1
<b>Supporting Courses</b>		
STAT 521	Applied regression analysis	2+1
<b>Non Credit Courses</b>		
PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skill	0+1
PGS 503	Intellectual Property and Its Management	1+0

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

<b>Major Courses</b>		
Pl. Path 604	Molecular Basis of Host Pathogen Interaction	2+1
Pl. Path 605	Principles and procedures of certification	1+0
Pl. Path 606	Plant Biosecurity and Biosefty	2+0

<b>Minor Courses</b>		
ENT 608	Advanced Host Plant Resistance	1+1
ENT 612	Advanced Integrated Pest Management	2+0
<b>Supporting Courses</b>		
STAT 531	Data Analysis using statistical packages	2+1
<b>Non Credit Courses</b>		
PGS 504	Basic Concept of Laboratory Technique	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS 506	Disaster Management	1+0

### **III<sup>rd</sup> –IV<sup>th</sup> Semester**

Pl. Path 691	Doctoral Seminar -I	0+1
Pl. Path 692	Doctoral Seminar -II	0+1

### **IV<sup>th</sup> –VI<sup>th</sup> Semester**

Pl. Path 699	Doctoral Research	0+45
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## **PL PATH 601 Advanced Mycology 2+1**

### **Objective**

To acquaint with the latest advances in Mycology.

### **Theory**

#### **UNIT I**

General introduction, historical development and advances in mycology.

#### **UNIT II**

Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy.

#### **UNIT III**

Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfect. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi.

#### **UNIT IV**

Population biology, pathogenic variability/vegetative compatibility.

#### **UNIT V**

Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

### **Practical**

Study of conidiogenesis- phialides, porospores, arthrospores. Study of fruitbodies in Ascomycotina. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of representative plant pathogenic genera from different groups of fungi.

### **Suggested Readings**

Alexopoulos CJ, Mimms CW & Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York.

Dube HC. 2005. *An Introduction to Fungi*. 3rd Ed. Vikas Publ. House, New Delhi.

Kirk PM, Cannon PF, David JC & Stalpers JA. (Eds.). 2001. *Ainsworth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington.

Ulloa M & Hanlin RT. 2000. *Illustrated Dictionary of Mycology*. APS, St. Paul, Mennisota.

Webster J & Weber R. 2007. *Introduction to Fungi*. Cambridge Univ. Press, Cambridge.

## **PL PATH 602 Advanced Virology 2+1**

### **Objective**

To educate about the advanced techniques and new developments in the field of Plant Virology.

### **Theory**

#### **UNIT I**

Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultra structural changes due to virus infection, variation, mutation and virus strains.

#### **UNIT II**

Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.

#### **UNIT III**

Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucummo, ilar and tospoviruses.

#### **UNIT IV**

Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.

#### **UNIT V**

Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.

## UNIT VI

Techniques and application of tissue culture. Origin, evolution and inter relationship with animal viruses.

### Practical

Purification of virus(es), SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii)DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing annotation of genes.

### Suggested Readings

- Davies 1997. *Molecular Plant Virology: Replication and Gene Expression*. CRC Press, Florida.
- Fauquet *et al.* 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press, New York.
- Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.
- Jones P, Jones PG & Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques*. John Wiley & Sons, New York.83
- Khan JA & Dijkstra. 2002. *Plant Viruses as Molecular Pathogens*. Howarth Press, New York.
- Maramorosch K, Murphy FA & Shatkin AJ. 1996. *Advances in Virus Research*. Vol. 46. Academic Press, New York.
- Pirone TP & Shaw JG. 1990. *Viral Genes and Plant Pathogenesis*. Springer Verlag, New York.
- Roger Hull 2002. *Mathew's Plant Virology* (4th Ed.). Academic Press, New York.
- Thresh JM. 2006. *Plant Virus Epidemiology*. Advances in Virus Research 67. Academic Press, New York.

## **PL PATH 603 Advanced Bacteriology 2+1**

### **Objective**

To provide knowledge about the latest advances in phytobacteriology.

### **Theory**

#### **UNIT I**

Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria.

#### **UNIT II**

Current trends in taxonomy of phytopathogenic procarya.

#### **UNIT III**

Role of enzyme, toxin, exopolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumifaciens*).

#### **UNIT IV**

Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

#### **UNIT V**

Molecular variability among phytopathogenic procarya and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens-gene silencing, RNAi technology.

#### **UNIT VI**

Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit.

#### **UNIT VII**

Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

## **Practical**

Pathogenic studies and race identification; plasmid profiling of bacteria; fatty acid profiling of bacteria; RAPD profiling of bacteria and variability status; Endospore, Flagiler staining; test for secondary metabolite production, cyanides, EPS, siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.

## **Suggested Readings**

- Dale JW & Simon P. 2004. *Molecular Genetics of Bacteria*. John Wiley & Sons, New York.84
- Garrity GM, Krieg NR & Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria*. Vol. II. Springer Verlag, New York.
- Gnanamanickam SS. 2006. *Plant-Associated Bacteria*. Springer Verlag, New York.
- Mount MS & Lacy GH. 1982. *Plant Pathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.
- Sigee DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects*. Cambridge Univ. Press, Cambridge.
- Starr MP. 1992. *The Prokaryotes*. Vols. I–IV. Springer Verlag, NewYork.

## **PL PATH 604 Molecular Basis of Host-Pathogen Interaction 2+1**

### **Objective**

To understand the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.

### **Theory**

#### **UNIT I**

Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.



## **UNIT II**

Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

## **UNIT III**

Induction of defense responses- pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing.

## **UNIT IV**

Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

## **UNIT V**

Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

### **Practical**

Protein, DNA and RNA isolation, Plasmids extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

### **Suggested Readings**

- Chet I. 1993. *Biotechnology in Plant Disease Control*. John Wiley & Sons, New York.
- Gurr SJ, McPherson MJ & Bowles DJ. (Eds.). 1992. *Molecular Plant Pathology - A Practical Approach*. Vols. I & II, Oxford Univ. Press, Oxford.
- Mathew JD. 2003. *Molecular Plant Pathology*. Bios Scientific Publ., UK.
- Ronald PC. 2007. *Plant-Pathogen Interactions: Methods in Molecular Biology*. Humana Press, New Jersey. 85

Stacey G & Keen TN. (Eds.). 1996. *Plant Microbe Interactions*. Vols. I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

## **PL PATH 605 Principles and Procedures of Certification 1+0**

### **Objective**

To acquaint with certification procedures of seed and planting material.

### **Theory**

#### **UNIT I**

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control.

#### **UNIT II**

Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc.

#### **UNIT III**

Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and *in vitro* cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

### **Suggested Readings**

Association of Official Seed Certifying Agencies.  
<http://www.aosca.org/index.htm>.

Hutchins D & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI, UK.

ISHI-veg *Manual of Seed Health Testing Methods*.  
[http://www.worldseed.org/enus/international\\_seed/ishi\\_vegetable.html](http://www.worldseed.org/enus/international_seed/ishi_vegetable.html)  
ISHI-F *Manual of Seed Health Testing Methods*.

[http://www.worldseed.org/en-us/international\\_seed/ishi\\_f.html](http://www.worldseed.org/en-us/international_seed/ishi_f.html) ISTA *Seed Health Testing Methods*. <http://www.seedtest.org/en/content---1--1132--241.html>

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System. <http://www.seedhealth.org/>

## **PL PATH 606 Plant Biosecurity and Biosafety 2+0**

### **Objective**

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

### **Theory**

#### **UNIT I**

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

#### **UNIT II**

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

### UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

#### Suggested Readings

FAO Biosecurity Toolkit 2008.

[www.fao.org/docrep/010/a1140e/a1140e00.htm](http://www.fao.org/docrep/010/a1140e/a1140e00.htm) Laboratory Biosecurity Guidance.

[http://www.who.int/csr/resources/publications/biosafety/WHO\\_CDS\\_EPR\\_2006.pdf](http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006.pdf)

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan*.

[http://www.americanprogress.org/kf/biosecurity\\_a\\_comprehensive\\_action\\_plan.pdf](http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_plan.pdf)

*Biosecurity Australia*. [www.daff.gov.au/ba](http://www.daff.gov.au/ba);

[www.affa.gov.au/biosecurityaustralia](http://www.affa.gov.au/biosecurityaustralia) *Biosecurity New Zealand*.

[www.biosecurity.govt.nz](http://www.biosecurity.govt.nz) DEFRA.

[www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm](http://www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm)

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001.

*Transgenic Crops and Biosafety Concerns*. NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production.

<http://www.fao.org/biosecurity/> CFIA.

<http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtml#7>

**Note: For minor courses please refer the concerned department's courses outline.**

**DEPARTMENT OF SOIL SCIENCE & AGRICULTURAL  
CHEMISTRY**

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

<b>Course No.</b>	<b>Title</b>	<b>Credits</b>
<b>Major Courses</b>		
SOIL 602	Advances in Soil Fertility	2+0
SOIL 603	Physical Chemistry of Soils	2+0
SOIL 605	Biochemistry of Soil Organic Matter	2+0
<b>Minor Courses</b>		
AGRON 604	Advances in Crop Growth and Productivity	2+1
AGRON 605	Irrigation Management	2+1
<b>Supporting Courses</b>		
STAT 521	Applied regression Analysis	2+1
<b>Non-Credit Courses</b>		
PGS501	Library & Information Services	0+1
PGS502	Technical Writing & Communication Skill	0+1
PGS503	Intellectual property & Its management in Agriculture	1+0

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

<b>Major Courses</b>		
SOIL 601	Advances in Soil Physics	2+0
SOIL 604	Soils Genesis and Micropedology	2+0
SOIL 505	Soil Erosion and Conservation	2+1
SOIL 606	Land use Planning and Watershed Management	2+0

<b>Minor Courses</b>		
AGRON 607	Integrated Farming System	2+0
AGRON 608	Soil Conservation and Watershed Management	2+1

<b>Supporting Courses</b>		
STAT 531	Data analysis using statistical packages	2+1
<b>Non-Credit Courses</b>		
PGS504	Basic Concept in Laboratory Technique	0+1
PGS505	Agricultural Research, Research Ethics and Rural development program	1+0
PGS506	Disaster Management	1+0

### **III<sup>rd</sup> –IV<sup>th</sup> Semester**

SOIL 691	Doctoral Seminar – I	0+1
SOIL 692	Doctoral Seminar - II	0+1

### **IV<sup>th</sup> –VI<sup>th</sup> Semester**

SOIL 699	Doctoral Research	0+45
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## **SOILS 605 Biochemistry of Soil Organic Matter 2+0**

### **Objective**

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

### **Theory**

#### **UNIT I**

Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.

#### **UNIT II**

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

#### **UNIT III**

Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.

#### **UNIT IV**

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes.

#### **UNIT V**

Humus - pesticide interactions in soil, mechanisms.

### **Suggested Readings**

- Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. *Organic Substances in Soil and Water: Natural Constituents and their Influences on Contaminant Behavior*. Royal Society of Chemistry, London.
- Gieseking JE. 1975. *Soil Components*. Vol. 1. *Organic Components*. Springer-Verlag.
- Kristiansen P, Taji A & Reganold J. 2006. *Organic Agriculture: A Global Perspective*. CSIRO Publ.

Magdoff F & Weil RR 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC Press.

Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture*. John Wiley & Sons.

Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.

Stevenson FJ. 1994. *Humus Chemistry – Genesis, Composition and Reactions*. John Wiley & Sons.

## **SOILS 602 Advances in Soil Fertility 2+0**

### **Objective**

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

### **Theory**

#### **UNIT I**

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

#### **UNIT II**

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

#### **UNIT III**

Chemical equilibria (including solid-solution equilibria) involving nutrients in soils, particularly in submerged soils.

#### **UNIT IV**

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

#### **UNIT V**

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.



## UNIT VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

### Suggested Readings

- Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.
- Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*. CRC / Taylor & Francis.
- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13<sup>th</sup> Ed. Pearson Educ.
- Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood & Sons.
- Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*. International Potash Institute, Switzerland.
- Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC/ Taylor & Francis.
- Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.
- Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture*. 2<sup>nd</sup> Ed. Soil Science Society of America, Madison.
- Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
- Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
- Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison.
- Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers*. 5<sup>th</sup> Ed. Macmillan Publ.
- Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11<sup>th</sup> Ed. Longman.

## **SOIL 603 Physical Chemistry of Soils 2+0**

### **Objective**

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

### **Theory**

#### **UNIT I**

Colloidal chemistry of inorganic and organic components of soils – their formation, clay organic interaction.

#### **UNIT II**

Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients; structure and properties of diffuse double layer.

#### **UNIT III**

Thermodynamics of nutrient transformations in soils; cationic and anionic exchange and their models, molecular interaction.

#### **UNIT IV**

Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

#### **UNIT V**

Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

### **Suggested Readings**

Bear RE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Fried M & Broeshart H. 1967. *Soil Plant System in Relation to Inorganic Nutrition*. Academic Press.

- Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.
- Greenland DJ & Hayes MHB. 1978. *Chemistry of Soil Constituents*. John Wiley & Sons.
- Jurinak JJ. 1978. *Chemistry of Aquatic Systems*. Dept. of Soil Science & Biometeorology, Utah State Univ.
- McBride MB. 1994. *Environmental Chemistry of Soils*. Oxford Univ. Press.
- Sparks DL. 1999. *Soil Physical Chemistry*. 2<sup>nd</sup> Ed. CRC Press.
- Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.
- Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.
- Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2<sup>nd</sup> Ed. John Wiley.
- Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

## **SOIL 604 Soil Genesis and Micropedology 2+0**

### **Objective**

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

### **Theory**

#### **UNIT I**

Pedogenic evolution of soils; soil composition and characterization.

#### **UNIT II**

Weathering and soil formation – factors and pedogenic processes; stability and weathering sequences of minerals.

#### **UNIT III**

Assessment of soil profile development by mineralogical and chemical analysis.

#### **UNIT IV**

Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

#### **Suggested Readings**

Boul SW, Hole ED, Mac Craken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4<sup>th</sup> Ed. Panima Publ.

Brewer R. 1976. *Fabric and Mineral Analysis of Soils*. John Wiley & Sons.

#### **SOIL 601 Advances in Soil Physics 2+0**

#### **Objective**

To provide knowledge of modern concepts in soil physics.

#### **Theory**

##### **UNIT I**

Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

##### **UNIT II**

Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy'slaw in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one-dimensional water flow.

##### **UNIT III**

Theories of horizontal and vertical infiltration under different boundary conditions.

##### **UNIT IV**

Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

## **UNIT V**

Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

## **UNIT VI**

Soil crust and clod formation; structural management of puddled rice soils; soil conditioning- concept, soils conditioners - types, characteristics, working principles, significance in agriculture.

## **UNIT VII**

Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

### **Suggested Readings**

- Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.
- Hanks and Ascheroff. 1980. *Applied Soil Physics*. Springer Verlag.
- Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
- Hillel D. 1980. *Environmental Soil Physics*. Academic Press.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley Interscience.
- Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
- Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

## **SOIL 606 Land use Planning and Watershed Management 2+0**

### **Objective**

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

### **Theory**

#### **UNIT I**

Concept and techniques of land use planning; factors governing present land use.

#### **UNIT II**

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

#### **UNIT III**

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production.

#### **UNIT IV**

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

#### **UNIT V**

Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

### **Suggested Readings**

All India Soil and Land Use Survey Organisation 1970. *Soil Survey Manual*. IARI, New Delhi.

FAO. 1976. *A Framework for Land Evaluation*, Handbook 32. FAO.

Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-Ecological Regions of India*. NBSS & LUP, Nagpur.

Soil Survey Staff 1998. *Keys to Soil Taxonomy*. 8<sup>th</sup> Ed. USDA & NRCS, Washington, DC.

USDA 1974. *A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers*. Oxford & IBH.

## **SOIL505 Soil Erosion and Conservation 2+1**

### **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 EI<sub>30</sub> 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 - suspension percentage,
- dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio,
- 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

### Suggested Readings

- Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.
- Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.
- Gurm Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
- Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

**Note: For minor courses please refer the concerned department's courses outline.**



## DEPARTMENT OF HORTICULTURE (FRUIT SCIENCE)

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

Course No.	Title	Credits
<b>Major Courses</b>		
FSC-601	Advances in Breeding of Fruit Crops	2+1
FSC-602	Advances in Production of Fruit Crops	2+1
FSC-603	Advances in Growth Regulation of Fruit Crops	2+1
<b>Minor Courses</b>		
VSC-601	Advances in Vegetable Production	2+1
VSC-603	Protected Cultivation of Vegetable Crops	1+1
<b>Supporting Courses</b>		
STAT-521	Applied Regression on Analysis	2+1
<b>Non Credit Courses</b>		
PGS-501	Library and Information Services	0+1
PGS-502	Technical Writing and Communications Skills	0+1
PGS-503	Intellectual Property and its Management in Agriculture	1+0

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

<b>Major Courses</b>		
FSC-605	Biotic and Abiotic Stress Management in Horticultural Crops	2+1
FSC-507	Post Harvest technology for fruit crops	2+1
<b>Minor Courses</b>		
VSC-605	Seed Certification, Processing and Storage of Vegetable Crops	2+1
VSC-606	Abiotic Stress Management in Vegetable Crops	2+1

<b>Supporting Courses</b>		
STAT-531	Data Analysis Using Statistical Package	2+1
<b>Compulsory Non Credit Courses</b>		
PGS-504	Basic Concepts in Laboratory Technology	0+1
PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS-506	Disaster Management	1+0

### **III<sup>rd</sup>-IV<sup>th</sup> Semester**

FSC-691	Doctoral Seminar -I	1+0
FSC-692	Doctoral Seminar -II	1+0

### **IV<sup>th</sup>-VI<sup>th</sup> Semester**

FSC-699	Doctoral Research	0+45
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## **FSC 601 advances in breeding of fruit crops 2+1**

### **Objective**

To update knowledge on the recent research trends in the field of breeding of fruit crops with special emphasis on tropical, subtropical and temperate crops grown in India.

### **Theory**

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits , recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops.

### **Crops**

**UNIT I :** Mango and banana

**UNIT II:** Papaya, grapes and citrus

**UNIT III:** Guava and sapota

**UNIT IV:** Pineapple and avocado

**UNIT V:** Apple, pear, plums, peaches, apricot, cherries and strawberry

### **Practical**

Description and cataloguing of germplasm, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagens and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

## Suggested Readings

- Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
- Gowen S. 1996. *Banana and Plantains*. Chapman & Hall.
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.
- Nijjar GS. (Ed.). 1977. *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagminder Book Agency.
- Stover RH & Simmonds NW. 1991. *Bananas*. Longman.

## FSC 602 Advances in Production of Fruit Crops 2+1

### Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

### Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

## Crops

**UNIT I :** Mango and banana

**UNIT II:** Papaya, grapes and citrus

**UNIT III:** Guava, sapota, pomegranate and aonla

**UNIT IV:** Pineapple, avocado, jack fruit and fig

**UNIT V:** Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

## Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

## Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits – Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical and Subtropical*. Naya Udyog.

Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. *Tropical Horticulture*. Vol. I. Naya Prokash.

Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vols. IIIIV. Malhotra Publishing House.

Chadha KL. 2001. *Handbook of Horticulture*. ICAR.

Nakasone HY & Paull RE. 1998. *Tropical Fruits*. CABI.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

## FSC 603 Advances in Growth Regulation of Fruit Crops 2+1

### Objective

Appraisal on the advances in growth regulation of fruit crops.

## **Theory**

### **UNIT I**

Ecophysiological influences on growth and development of fruit crops flowering, fruit set- Crop load and assimilate partitioning and distribution.

### **UNIT II**

Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.

### **UNIT III**

Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

### **UNIT IV**

Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

### **UNIT V**

Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.

## **Practical**

Root- shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruitset and fruit development stages.

## **Suggested Readings**

Buchanan B, Gruissem W & Jones R. 2002. *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.

- Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.
- Fosket DE. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press.
- Leopold AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3<sup>rd</sup> Ed. McGraw-Hill.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
- Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

## **FSC 507 Post Harvest Technology for Fruit Crops 2+1**

### **Objective**

To facilitate deeper understanding on principles and practices of postharvest management of fruit crops.

### **Theory**

#### **UNIT I**

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

#### **UNIT II**

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

#### **UNIT III**

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

#### **UNIT IV**

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

## UNIT V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

### Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

### Suggested Readings

- Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.
- Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.
- Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.
- Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.
- Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
- Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
- Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.



## **FSC 605 Biotic and Abiotic Stress Management in Horticultural Crops 2+1**

### **Objective**

To update knowledge on the recent research trends in the field of biotic and abiotic stress management in horticultural crops.

### **Theory**

#### **UNIT I**

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

#### **UNIT II**

Pollution - increased level of CO<sub>2</sub>, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

#### **UNIT III**

Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

#### **UNIT IV**

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

#### **UNIT V**

Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

## Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

## Suggested Readings

- Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC.
- Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley Inter. Science.
- Gupta US. 1990. *Physiological Aspects of Dry Farming*.
- Hsiao TC. 1973. Plant Responses to Water Stress. *Ann. Rev. Plant Physiology* 24:519-570.
- Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.
- Levitt J. 1972. *Response of Plants to Environmental Stresses*. Academic Press.
- Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.
- Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.
- Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.
- Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.
- Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

**Note :** For minor courses please refer the concerned department's courses outline.

## DEPARTMENT OF HORTICULTURE (VEGETABLE SCIENCE)

### I Semester

Course No.	Title	Credits
<b>Major Courses</b>		
VSC-601	Advances in Vegetable Production	2+1
VSC-602	Advances in Breeding of Vegetable Crops	2+1
VSC-603	Protected Cultivation of Vegetable Crops	1+1
VSC-604	Bio-Technologies in Vegetable Crops	2+1
<b>Minor Courses</b>		
FSC-602	Advances in Production of Fruit Crops	2+1
FSC-603	Advances in Growth Regulation of Fruit Crops	1+1
<b>Supporting Courses</b>		
STAT-521	Applied Regression on Analysis	2+1
<b>Non Credit Courses</b>		
PGS-501	Library and Information Services	0+1
PGS-502	Technical Writing and Communications Skills	0+1
PGS-503	Intellectual Property and its Management in Agriculture	1+0

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

<b>Major Courses</b>		
VSC-605	Seed Certification, Processing and Storage of Vegetable Crops	2+1
VSC-606	Abiotic Stress Management in Vegetable Crops	2+1

<b>Minor Courses</b>		
FSC-507	Post Harvest technology for fruit crops	2+0
FSC-605	Biotic and Abiotic Stress Management in Horticultural Crops	2+0
<b>Supporting Courses</b>		
STAT-531	Data Analysis Using Statistical Package	2+1
<b>Non Credit Courses</b>		
PGS-504	Basic Concepts in Laboratory Technology	0+1
PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
PGS-506	Disaster Management	1+0

### **III<sup>rd</sup>-IV<sup>th</sup> Semester**

VSC-691	Doctoral Seminar I	1+0
VSC-692	Doctoral Seminar II	1+0

### **IV<sup>th</sup>-VI<sup>th</sup> Semester**

VSC-699	Doctoral Research	0+45
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## **VSC 601 Advances in Vegetable Production 2+1**

### **Objective**

To keep abreast with latest developments and trends in production technology of vegetable crops.

### **Theory**

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

**UNIT I** : Tomato, brinjal, chilli, sweet pepper and potato

**UNIT II** : Cucurbits, cabbage, cauliflower and knol-khol

**UNIT III** : Bhendi, onion, peas and beans, amaranthus and drumstick

**UNIT IV** : Carrot, beet root and radish

**UNIT V** : Sweet potato, tapioca, elephant foot yam and taro

### **Practical**

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dry land techniques for rainfed vegetable production; production constraints;

analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ; marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

### **Suggested Readings**

- Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI. FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.
- Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.
- Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.
- Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
- Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.
- Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.
- Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.
- Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

### **VSC 602 Advances in Breeding of Vegetable Crops 2+1**

#### **Objective**

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

## Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of:

**UNIT I :** Tomato, brinjal, chilli, sweet pepper and potato

**UNIT II :** Cucurbits, Cabbage, cauliflower and knol-khol

**UNIT III :** Bhendi, onion, peas and beans, amaranthus and drumstick

**UNIT IV :** Carrot, beet root and radish

**UNIT V :** Sweet potato, tapioca, elephant foot yam and taro

## Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for-quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

## Suggested Readings

*Acta Horticulture*. Conference on Recent Advance in Vegetable Crops. Vol. 127.

Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House.

Chadha KL. 2001. *Hand Book of Horticulture*. ICAR.

- Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
- Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co.
- Kaloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.
- Kaloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks.
- Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.
- Ram HH. 2001. *Vegetable Breeding*. Kalyani.

### **VSC 603 Protected Cultivation of Vegetable Crops 1+1**

#### **Objective**

To impart latest knowledge in growing of vegetable crops under protected environmental condition.

#### **Theory**

**Crops:** Tomato, capsicum, cucumber, melons and lettuce

#### **UNIT I**

Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

#### **UNIT II**

Regulatory structures used in protected structures; types of greenhouse / polyhouse / nethouse, hot beds, cold frames, effect of environmental factors, viz. temperature, light, CO<sub>2</sub> and humidity on growth of different vegetables, manipulation of CO<sub>2</sub>, light and temperature for vegetable production, fertigation.

#### **UNIT III**

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



## **UNIT IV**

Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, weat pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

## **UNIT V**

Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.

### **Practical**

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

### **Suggested Readings**

Anonymous 2003. *Proc. All India Seminars on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

Chandra S & Som V. 2000. *Cultivating Vegetables in Green House*. *Indian Horticulture* 45: 17-18.

Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2nd Ed. Agrobios.

Tiwari GN. 2003. *Green House Technology for Controlled Environment*. Narosa Publ. House.

## **VSC 604 Biotechnologies in Vegetable Crops 2+1**

### **Objective**

To teach advances in biotechnology for improvement of vegetable crops.

### **Theory**

Crops: Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

## **UNIT I**

*In vitro* culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somoclonal variants and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites.

## **UNIT II**

Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation.

## **UNIT III**

*In vitro* mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology.

## **UNIT IV**

Quality improvement, improvement for biotic and abiotic stresses, transgenic plants.

## **UNIT V**

Role of molecular markers in characterization of transgenic crops, finger printing of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology.

## **Practical**

Establishment of axenic explants, callus initiation and multiplication, production of suspension culture, cell and protoplast culture, fusion, regeneration and identification of somatic hybrids and cybrids; Identification of embryonic and non-embryonic calli, development of cell lines; *in vitro* mutant selection for biotic and abiotic stresses, *In vitro* production and characterization of secondary metabolites, isolated microspore culture, isolation and amplification of DNA, gene transfer methods, molecular characterization of transgenic plants.

## Suggested Readings

- Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry*. Vol.XIX. *Hitech and Micropropagation*. Springer.
- Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops*. Malhotra Publ. House.
- Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ.
- Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.
- Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.
- Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press).
- Keshavachandran R et al. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency.
- Panopoulos NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.
- Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
- Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
- Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.
- Sharma R. 2000. *Plant Tissue Culture*. Campus Books.
- Singh BD. 2001. *Biotechnology*. Kalyani.
- Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro*. Attidel. II Symp. On Biotechnology Action of Growth Substance.
- Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants*. *Plant Regulation and World Agriculture*. Planum Press.
- Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V.

## **VSC 605 Seed Certification, Processing and Storage of Vegetable Crops 2+1**

### **Objective**

To educate the recent trends in the certification, processing and storage of vegetable crops.

### **Theory**

#### **UNIT I**

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification.

#### **UNIT II**

Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number.

#### **UNIT III**

Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control.

#### **UNIT IV**

Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy.

#### **UNIT V**

Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy.

### **Practical**

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of

seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

### **Suggested Readings**

Agrawal PK & Dadlani M. 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi.

Rajan S & Baby L Markose 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

## **VSC 606 Abiotic Stress Management in Vegetable 2+1**

### **Crops**

### **Objective**

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

### **Theory**

#### **UNIT I**

Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of antitranspirants.

## **UNIT II**

Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

## **UNIT III**

Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

## **UNIT IV**

Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

## **UNIT V**

Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

### **Practical**

Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops, measurement of tolerance to various stresses in vegetable crops, short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

### **Suggested Readings**

Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.

Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.

Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.

**Note : For minor courses please refer the concerned department's course outline.**

## Course Curriculum of Supporting/Non-credit Courses of PG & Ph.D. Degree Programme

### SUPPORTING COURSES FOR PG DEGREE PROGRAMME

STAT 511	Statistical Methods and applied sciences	3+1
STAT-512	Experimental design	2+1
STAT 513	Sampling techniques	2+1

### SUPPORTING COURSES FOR Ph.D. DEGREE PROGRAMME

STAT 521	Applied regression on analysis	2+1
STAT 531	Data analysis using statistical package	2+1

### NON CREDIT COURSES FOR PG/Ph.D. DEGREE PROGRAMME

PGS 501	Library and information services	0+1
PGS 502	Technical writing & communication skills	0+1
PGS 503	Intellectual property its management in Agriculture	1+0
PGS 504	Basic concepts in laboratory techniques	0+1
PGS 505	Agriculture research, Research, ethics and rural development programme	1+0
PGS 506	Disaster management	1+0



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## SUPPORTING COURSES FOR PG DEGREE PROGRAMME

### PG (Ag./Hort.)

#### 1. STAT 511 / STATISTICAL METHODS FOR APPLIED SCIENCES 3+1

##### Objective

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

##### Theory

###### UNIT I

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

###### UNIT II

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

###### UNIT III

Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting.



Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

#### **UNIT IV**

Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

#### **UNIT V**

Introduction to multivariate analytical tools- Hotelling's  $T^2$  Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D2-statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

#### **Practical**

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

#### **Suggested Readings**

Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.

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

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

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

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

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

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

Siegel S, Johan N & Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley. Learning Statistics:  
<http://freeststatistics.altervista.org/en/learning.php>. Electronic Statistics Text Book:  
<http://www.statsoft.com/textbook/stathome.html>.

## **2. STAT 512 / EXPERIMENTAL DESIGNS 2+1**

### **Objective**

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

### **Theory**

#### **UNIT I**

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

#### **UNIT II**

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

#### **UNIT III**

Factorial experiments, (symmetrical as well as asymmetrical) orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

#### **UNIT IV**

Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs;

Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design - concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

#### **UNIT V**

Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

#### **Practical**

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

#### **Suggested Readings**

- Cochran WG & Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
- Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer.
- Federer WT. 1985. *Experimental Designs*. MacMillan.
- Fisher RA. 1953. *Design and Analysis of Experiments*. Oliver & Boyd.
- Nigam AK & Gupta VK. 1979. *Handbook on Analysis of Agricultural Experiments*. IASRI Publ.
- Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice*. John Wiley. Design Resources Server: [www.iasri.res.in/design](http://www.iasri.res.in/design).

### **3. STAT 513/ SAMPLING TECHNIQUES 2+1**

#### **Objective**

This course is meant for students of agricultural and animal sciences other than Statistics. The students would be exposed to elementary sampling techniques. It would help them in understanding the concepts

involved in planning and designing their surveys, presentation of survey data analysis of survey data and presentation of results. This course would be especially important to the students of social sciences.

## **Theory**

### **UNIT I**

Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.

### **UNIT II**

Simple random sampling, sampling for proportion, determination of sample size; inverse sampling, Stratified sampling.

### **UNIT III**

Cluster sampling, PPS sampling, Multi-stage sampling, double sampling, systematic sampling; Use of auxiliary information at estimation as well as selection stages.

### **UNIT IV**

Ratio and regression estimators, Construction and analysis of survey designs, sampling and non-sampling errors; Preparation of questionnaire Non-sampling errors.

## **Practical**

Random sampling ~ use of random number tables, concepts of unbiasedness, variance, etc.; simple random sampling, determination of sample size; Exercises on inverse sampling, stratified sampling, cluster sampling and systematic sampling; Estimation using ratio and regression estimators; Estimation using multistage design, double sampling and PPS sampling.

## **Suggested Readings**

- Cochran WG. 1977. *Sampling Techniques*. John Wiley.
- Murthy MN. 1977. *Sampling Theory and Methods*. 2nd Ed. Statistical Publ. Soc., Calcutta.
- Singh D, Singh P & Kumar P. 1982. *Handbook on Sampling Methods*. IASRI Publ.
- Sukhatme PV, Sukhatme BV, Sukhatme S & Asok C. 1984. *Sampling Theory of Surveys with Applications*. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

## **SUPPORTING COURSE OF PH.D. (AG./HORT.)**

### **1. STAT 521/ APPLIED REGRESSION ANALYSIS 2+1**

#### **Objective**

This course is meant for students of all disciplines including agricultural and animal sciences. The students would be exposed to the concepts of correlation and regression. Emphasis will be laid on diagnostic measures such as autocorrelation, multicollinearity and heteroscedasticity. This course would prepare students to handle their data for analysis and interpretation.

#### **Theory**

##### **UNIT I**

Introduction to correlation analysis and its measures; Correlation from grouped data, Biserial correlation, Rank correlation; Testing of population correlation coefficients; Multiple and partial correlation coefficients and their testing.

##### **UNIT II**

Problem of correlated errors; Auto correlation; Durbin Watson Statistics; Removal of auto correlation by transformation; Analysis of collinear data; Detection and correction of multicollinearity; Regression analysis;

Method of least squares for curve fitting; Testing of regression coefficients; Multiple and partial regressions.

### **UNIT III**

Examining the multiple regression equation; Concept of weighted least squares; regression equation on grouped data; Various methods of selecting the best regression equation; regression approach applied to analysis of variance in one way classification.

### **UNIT IV**

Heteroscedastic models, Concept of nonlinear regression and fitting of quadratic, exponential and power curves; Economic and optimal dose, Orthogonal polynomial.

### **Practical**

Correlation coefficient, various types of correlation coefficients, partial and multiple, testing of hypotheses; Multiple linear regression analysis, partial regression coefficients, testing of hypotheses, residuals and their applications in outlier detection; Handling of correlated errors, multicollinearity; Fitting of quadratic, exponential and power curves, fitting of orthogonal polynomials.

### **Suggested Readings**

Draper NR & Smith H. 1998. *Applied Regression Analysis*. 3rd Ed. John Wiley.

Ezekiel M. 1963. *Methods of Correlation and Regression Analysis*. John Wiley.

Kleinbaum DG, Kupper LL, Muller KE & Nizam A. 1998. *Applied Regression Analysis and Multivariable Methods*. Duxbury Press.

Koutsoyiannis A. 1978. *Theory of Econometrics*. MacMillan.

Kutner MH, Nachtsheim CJ & Neter J. 2004. *Applied Linear Regression Models*. 4th Ed. With Student CD. McGraw Hill.

## **2. STAT 531/ DATA ANALYSIS USING STATISTICAL PACKAGES 2+1**

### **Objective**

This course is meant for exposing the students in the usage of various statistical packages for analysis of data. It would provide the students an hands on experience in the analysis of their research data. This course is useful to all disciplines.

### **Theory**

#### **UNIT I**

Use of Software packages for: Summarization and tabulation of data; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

#### **UNIT II**

Fitting and testing the goodness of fit of discrete and continuous probability distributions; Testing of hypothesis based on large sample test statistics; Testing of hypothesis using chi-square,  $t$  and  $F$  statistics.

#### **UNIT III**

Concept of analysis of variance and covariance of data for single factor, multi-factor, one-way and multi-classified experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

#### **UNIT IV**

Analysis of mixed models; Estimation of variance components; Testing the significance of contrasts; Correlation and regression including multiple regression.

#### **UNIT V**

Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Time series data; Spatial analysis; Neural networks.

## Practical

Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data. Robust Estimation, Testing linearity and normality assumption, Estimation of trimmed means etc., Cross tabulation of data including its statistics, cell display and table format and means for different sub-classifications; Fitting and testing the goodness of fit of probability distributions; Testing the hypothesis for one sample  $t$ -test, two sample  $t$ -test, paired  $t$ -test, test for large samples - Chi-squares test, F test, One way analysis of variance, contrast and its testing, pairwise comparisons; Multiway classified analysis of variance - cross-classification, nested classification, factorial set up, fixed effect models, random effect models, mixed effect models, estimation of variance components; Generalized linear models - analysis of unbalanced data sets, testing and significance of contrasts, Estimation of variance components in unbalanced data sets - maximum likelihood, ANOVA, REML, MINQUE; Bivariate and partial correlation, Distances - to obtain a distance matrix, dissimilarity measures, similarity measures; Linear regression, Multiple regression, Regression plots, Variable selection, Regression statistics, Fitting of growth models - curve estimation models, examination of residuals; Discriminant analysis - fitting of discriminant functions, identification of important variables, Factor analysis. Principal component analysis - obtaining principal component, spectral composition; Analysis of time series data - fitting of ARIMA models, working out moving averages. Spatial analysis; Neural networks.

## Suggested Readings

- Anderson CW & Loynes RM. 1987. *The Teaching of Practical Statistics*. John Wiley.
- Atkinson AC. 1985. *Plots Transformations and Regression*. Oxford University Press.
- Chambers JM, Cleveland WS, Kleiner B & Tukey PA. 1983. *Graphical Methods for Data Analysis*. Wadsworth, Belmont, California.
- Chatfield C & Collins AJ. 1980. *Introduction to Multivariate Analysis*. Chapman & Hall.



- Chatfield C. 1983. *Statistics for Technology*. 3rd Ed. Chapman & Hall.
- Chatfield C. 1995. *Problem Solving: A Statistician's Guide*. Chapman & Hall.
- Cleveland WS. 1985. *The Elements of Graphing Data*. Wadsworth, Belmont, California.
- Ehrenberg ASC. 1982. *A Primer in Data Reduction*. John Wiley.
- Erickson BH & Nosanchuk TA. 1992. *Understanding Data*. 2nd Ed. Open University Press, Milton Keynes.
- Snell EJ & Simpson HR. 1991. *Applied Statistics: A Handbook of GENSTAT Analyses*. Chapman & Hall.
- Sprent P. 1993. *Applied Non-parametric Statistical Methods*. 2nd Ed. Chapman & Hall.
- Tufte ER. 1983. *The Visual Display of Quantitative Information*. Graphics Press, Cheshire, Conn.
- Velleman PF & Hoaglin DC. 1981. *Application, Basics and Computing of Exploratory Data Analysis*. Duxbury Press.
- Weisberg S. 1985. *Applied Linear Regression*. John Wiley.
- Wetherill GB. 1982. *Elementary Statistical Methods*. Chapman & Hall.
- Wetherill GB. 1986. *Regression Analysis with Applications*. Chapman & Hall.
- Learning Statistics: <http://freestatistics.altervista.org/en/learning.php>.
- Free Statistical Softwares: <http://freestatistics.altervista.org/en/stat.php>.
- Statistics Glossary [http://www.cas.lancs.ac.uk/glossary\\_v1.1/main.html](http://www.cas.lancs.ac.uk/glossary_v1.1/main.html).
- Course on Experimental design:  
<http://www.stat.sc.edu/~grego/courses/stat706/>.
- Design Resources Server: [www.iasri.res.in/design](http://www.iasri.res.in/design).
- Analysis of Data: Design Resources Server.  
<http://www.iasri.res.in/design/Analysis%20of%20data/Analysis%20of%20Data.html>.

## NON CREDIT COURSES FOR PG/Ph.D. DEGREE PROGRAMME

### PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

#### Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

#### Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.) Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

### PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1

#### Objective

- To equip the students/scholars with skills to write dissertations, research papers, etc.
- To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

#### Practical

**Technical Writing** - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental

results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

**Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

### **Suggested Readings**

- Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary*. 1995. Harper Collins.
- Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
- James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
- Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
- Richard WS. 1969. *Technical Writing*. Barnes & Noble.
- Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
- Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2<sup>nd</sup> Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

## **PGS 503 INTELLECTUAL PROPERTY AND ITS 1+0 (e-Course) MANAGEMENT IN AGRICULTURE**

### **Objective**

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

### **Theory**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

### **Suggested Readings**

- Erbisch FH & Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
- Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

*The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*

## **PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1**

### **Objective**

To acquaint the students about the basics of commonly used techniques in laboratory.

### **Practical**

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

## **Suggested Readings**

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

## **PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS 1+0 (e-Course) AND RURAL DEVELOPMENT PROGRAMMES**

### **Objective**

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

### **Theory**

#### **UNIT I**

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

#### **UNIT II**

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

#### **UNIT III**

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme,

Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

### **Suggested Readings**

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

## **PGS 506 DISASTER MANAGEMENT 1+0**

**(e-Course)**

### **Objectives**

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

### **Theory**

#### **UNIT I**

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

#### **UNIT II**

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

### **UNIT III**

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

#### **Suggested Readings**

- Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
- Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.