

## Department of Agronomy

### Name of the Programme: Ph.D. Agronomy

### Courses offer in Master Degree programme

Group		Number	Title of Course	Credit
Major	1	AGRON 601	Current trends in agronomy	3(3+0)
	2	AGRON 603	Crop production and system modeling	3(2+1)
	3	AGRON 604	Advances in plant growth and productivity	3(2+1)
	4	AGRON 605	Irrigation management	3(2+1)
	5	AGRON 606	Advances in weed management	2(2+0)
	6	AGRON 607	Integrated farming system	2(2+0)
	<b>Total</b>			<b>16(13+3)</b>
Seminar		AGRON 691	Credit Seminar	<b>2(0+2)</b>
Research		AGRON 699	Research	<b>45(0+45)</b>
Minor	1	A SOILS 602	Advances in soil fertility	2(2+0)
	2	A SOILS 605	Bio-chemistry of soil organic matter	2(2+0)
	3	APP 605	Climate change and crop growth	2(2+0)
	4	A PP 608	Seed Physiology	3(2+1)
	<b>Total</b>			<b>9(8+1)</b>
Supporting	1	A STAT 521	Applied Regression Analysis	3(2+1)
	2	A STAT 531	Data Analysis Using Statistical Packages	3(2+1)
	<b>Total</b>			<b>6 (4+2)</b>
Non-Credit Compulsory Course	1.	PGS 501	Library and Information Services	0+1
	2.	PGS 502	Technical Writing and Communications Skills	0+1
	3.	PGS 503	Intellectual Property and its Management in Agriculture	0+1
	4.	PGS 504	Basic Concepts in Laboratory Techniques	0+1
	5.	PGS 505	Agri Res. Ethics and Rural Dev. Programs	0+1
	6.	PGS 506	Disaster Management	0+1
	7.		Human value and Professional Ethics	1+1
	<b>Total</b>			<b>8(1+7)</b>
<b>Grand total</b>				<b>86( 26+60)</b>

**Department of Agronomy**

**Name of the Programme: Ph.D. Agronomy**

**Minimum credit requirements**

<b>Subject</b>	<b>Master</b>
<b>Major</b>	<b>16</b>
<b>Minor</b>	<b>09</b>
<b>Supporting</b>	<b>06</b>
<b>Seminar</b>	<b>02</b>
<b>Thesis research</b>	<b>45</b>
<b>Total</b>	<b>78</b>

**Department of Agronomy**  
**Name of the Programme: Ph.D. Agronomy**  
**Semester wise distribution of courses**

Course	Course Title	Code	Credits
<b>Semester – I</b>			
<b>Major</b>	Current trends in agronomy	AGRON 601	3 (3+0)
	Crop production and system modeling	AGRON 603	3 (2+1)
	Integrated farming system	AGRON 607	2 (2+0)
<b>Minor</b>	Advances in soil fertility	A SOILS 602	2 (2+0)
	Climate change and crop growth	APP 605	2 (2+0)
	Bio-chemistry of soil organic matter	A SOILS 605	2 (2+0)
<b>Supporting</b>	Applied regression analysis	ASTAT 521	3 (2+1)
	Library and information services	PGS 501	1 (0+1)
	Intellectual Property and its Management in Agriculture	PGS- 503	1 (0+1)
	Basic concept of laboratory techniques	PGS 504	1 (0+1)
<b>Semester – II</b>			
<b>Major</b>	Advances in plant growth and productivity	AGRON 604	3 (2+1)
	Advances in weed management	AGRON 606	2 (2+0)
	Irrigation management	AGRON 605	3 (2+1)
<b>Minor</b>	Seed physiology	APP 608	3 (2+1)
<b>Supporting</b>	Data analysis using statistical package	ASTAT 531	3 (2+1)
	Technical Writing and Communication Skills	PGS- 502	1 (0+1)
	Agricultural research, research ethics and rural development programmes	PGS 505	1 (1+0)
	Disaster management	PGS 506	1 (1+0)
<b>Semester III</b>			
	<i>Written and Oral Comprehensive Examination</i>	-	
	Seminar	AGRON 691	2(0+2)



<b>AGRON 602</b>	<b>Crop Ecology</b>	<b>(2+0)</b>
<b>Objective</b>	To acquaint the students about the agricultural systems, agroecological regions and adaptation of crops to different agroclimatic conditions	
<b>Theory</b>		
<b>UNIT I</b>	Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.	
<b>UNIT II</b>	Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.	
<b>UNIT III</b>	Physiological response of crop plants to light, temperature, CO <sub>2</sub> , moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.	
<b>UNIT IV</b>	Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.	
<b>UNIT V</b>	Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.	

### **Suggested Readings**

- Ambasht RS. 1986. A Text Book of Plant Ecology. 9th Ed. Students' Friends & Co.
- Chadha KL & Swaminathan MS. 2006. Environment and Agriculture. Malhotra Publ. House.
- Dwivedi P, Dwivedi SK & Kalita MC. 2007. Biodiversity and Environmental Biotechnology. Scientific Publ.
- Hemantarajan A. 2007. Environmental Physiology. Scientific Publ.
- Kumar HD. 1992. Modern Concepts of Ecology. 7th Ed. Vikas.Publ.
- Lenka D. 1998. Climate, Weather and Crops in India. Kalyani.
- Misra KC. 1989. Manual of Plant Ecology. 3rd Ed. Oxford & IBH.
- Pandey SN & Sinha BK. 1995. Plant Physiology. Vikas Publ.
- Sharma PD. 1998. Ecology and Environment. Rastogi Publ.
- Singh J & Dhillon SS. 1984. Agricultural Geography. Tata McGraw Hill.
- Taiz L & Zeiger E. 1992. Plant Physiology. Benjamin/Cummings Publ.

**AGRON 603 Crop Production and System Modeling(2+1)**

**Objective** To familiarize the students about systems approach and to stimulate yields and growth of several crops under varied soil and weather conditions with different management practices and their optimization.

**Theory**

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

**UNIT II** Elementary models for crop growth based on basic methods of classical growth analysis.

**UNIT III** Crop modeling methods for crop-weather interaction, climate change and variability components.

**UNIT IV** Potential production: leaf and canopy CO<sub>2</sub> assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.

**UNIT V** Production by moisture availability, potential evapotranspiration, water balance of the soil, and production with nutrient and moisture limitations.

**Practical**

- Simulation of elementary models for crop growth
- Simulation of potential production
- Simulation with limitations of water and nutrient management options
- Sensitivity analysis using different climatic years and crop management practices

**Suggested Readings**

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

Kropff MJ & Vann Laar HH. (Ed.). 1993. Modelling Crop Weed Interactions.

Mathews RB, Kriff MJ, bachelet D and Vaanlaar HH. EDn. 1993. Modelling the Impact of Climate Change on Rice Production in Asia. CABI.

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

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

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

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

**Objective**        To study the physiology of vegetative growth in relation to productive 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
- 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 etc in intercropping
- Senescence and abscission indices
- Analysis of productivity trend in irrigated areas
- Analysis of productivity trend in un-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. 1996. Crop Evolution, Adaptation and Yield. Cambridge Univ. Press.

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

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





Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water Kalyani Publ.

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

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

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

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

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

Kewat, M.L. & Sharma, R.S. (2007). A practical manual for weed control, College of Agriculture, JNKVV, Jabalpur

**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 in different systems through research; eco-physiological approaches to intercropping.

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

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

**Suggested Readings**

- 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 SC. 2004. Cropping systems and Farming Systems. Agribios.
- Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.
- Sharma AK. 2001. A Hand Book of Organic Farming. Agrobios.
- Singh SP. (Ed) 1994. Technology for Production of Natural Enemies. PDBC, Bangalore.
- Trivedi RN. 1993. A Text Book of Environmental Sciences. Anmol Publ.
- Veeresh GK, Shivashankar K & Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore.
- Venkata Rao BV. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective. Publ. 3. Parisaraprajna Parishtana, Bangalore.

**AGRON 608      Soil Conservation and Watershed Management(2+1)**

**Objective**      To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach and 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 V.V. 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 VN. 1995. Land and Water Management Engineering. Kalyani.
- Tripathi RP & Singh HP. 1993. Soil Erosion and Conservation. Wiley Eastern.
- Yellamanda Reddy T&Sankara Reddy GH. 1992. Principles of Agronomy.Kalyani.

**AGRON 609 Stress Crop Production**

**(2+1)**

**Objective** To study various types of stresses in crop production and strategies to overcome them

**Theory**

- UNIT I** Stress and strain terminology; nature and stress injury and resistance; causes of stress.
- UNIT II** Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress through soil and crop manipulations.
- UNIT III** High temperature: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.
- UNIT IV** Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop manipulations.
- UNIT V** Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.
- UNIT VI** Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.
- UNIT VII** Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.
- UNIT VIII** Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

**Practical**

- Determination of electrical conductivity of plant cell sap
- Determination of osmotic potential and tissue water potential
- Measurement of transpiration rate
- Measurement of stomatal frequency
- Growing of plants in sand culture under salt stress
- Studies on effect of osmotic and ionic stress on seed germination and seedling growth
- Measurement of low temperature injury under field conditions

**Suggested Readings**

- Baker FWG. 1989. Drought Resistance in Cereals. Oxon, UK.
- Gupta U.S. (Ed.). 1988. Physiological Aspects of Dryland Farming. Oxford & IBH.
- Kramer PJ. 1983. Water Relations of Plants. Academic Press.
- Nilsen ET & Orcut DM. 1996. Physiology of Plants under Stress – Abiotic Factors. John Wiley & Sons.
- Singh K. 2000. Plant Productivity under Environmental Stress. Agribios.
- Singh KN & Singh RP. 1990. Agronomic Research Towards Sustainable Agriculture. ISA, New Delhi.
- Somani LL & Totawat KL. 1992. Management of Salt-affected Soils and Waters. Agrotech Publ.
- Virmani SM, Katyal JC, Eswaran H & Abrol IP. 1994. Stressed Ecosystem and Sustainable Agriculture. Oxford & IBH.

**PP 605            Climate Change and Crop Growth            2+0**

**Objective**            To impart knowledge about climate change and its implication to crop growth.

**Theory**

**UNIT I**            History and evidences of climate change and its implications. Effect of climate change on monsoons, hydrological cycle and water availability.

**UNIT II**            Natural and anthropogenic activities and agricultural practices on GHG production, Monitoring of greenhouse gases and their influence on global warming and climate change, Ozone depletion leading to increased ionizing radiations and its implications on crop growth.

**UNIT III**            Long-term and short-term projections of climate change effects on natural vegetations and ecosystems, crop-pest interaction, area shift, food production and supply.

**UNIT IV**            Approaches to mitigate climate change through studies on plant responses.

**UNIT V**            Direct and indirect effects of climate change on plant processes – phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.

**UNIT VI**            Conventional and biotechnological approaches to improve the crop adaptation to climate change. Relevance of “Genome wide mutants” to identify genes/processes for improved adaptation to changing environments

**UNIT VII**            International conventions and global initiatives on Carbon sequestration, carbon trading.

**Suggested Readings**

Abrol YP & Gadgil S. (Eds.). 1999. Rice in a Changing Climate.

Reddy KR & Hodges HF. 2000. Climate Change and Global Crop Productivity. CABI.

Watson RT, Zinyowera MC & Moss RH. 1998. The Regional Impacts of Climate Change - an Assessment of Vulnerability. Cambridge Univ. Press. 98

**PP 608      Seed Physiology2+1**

**Objective**      To apprise students regarding seed germination, dormancy and physiological processes involved in regulation of seed development

**Theory**

**UNIT I**      Seed and fruit development, seed and fruit abortion, proximate mechanism of seed and fruit abortion. Hereditary and environmental effect on seed development. Gene imprints and seed development.

**UNIT II**      Importance of seeds, seed structure and function, physiological and biochemical changes, environmental influences, physiology of seed and fruit development; seed and fruit abortion and means to overcome it; proximate mechanisms of seed and fruit abortion.

**UNIT III**      Structure of seeds and their storage resources, seed developmental patterns and source of assimilates for seed development.

**UNIT IV**      Pathway of movement of assimilates in developing grains of monocots and dicots, Chemical composition of seeds, Storage of carbohydrates, proteins and fats in seeds and their biosynthesis.

**UNIT V**      Seed respiration, mitochondrial activity, Seed ageing, Mobilization of stored resource in seeds, Chemistry of oxidation of starch, proteins and fats, Utilization of breakdown products by embryonic axis.

**UNIT VI**      Control processes in mobilization of stored resources, Role of embryonic axes, Gibberlin and  $\alpha$ -amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, Role of LEA proteins.

**UNIT VII**      Seed viability, Physiology of and means to prolong seed viability, Seed vigour concept, importance, measurement; invigoration methods and physiological basis of it, Seed dormancy, types and regulation, Means to overcome seed dormancy.

**Practical**

- Determination of seed storage proteins, Sink drawing ability of ovules, empty ovule technique, Alpha-amylase activity in germinating seeds.
- Role of GA in inducing amylase activity. Role of embryo in GA induced amylase activity, Protease and lipase activity in germinating seeds.
- Seed viability test and accelerated ageing test.
- Seed hardening/osmotic priming of seeds, seed respiration rates, seed viability losses through membrane leakage studies.

**Suggested Readings**

Bewley JD & Black M. 1985. Seed Physiology of Development and Germination. Plenum Publ.  
Copeland LO & McDonald MB. Principles of Seed Sciences and Technology. Burgers Publ. Co.  
Srivastav L.M. Plant Growth and Development - Hormones and Environment, Academic Press. 101

**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 nutrient ions in soils, particularly in submerged soils.

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

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

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

**Suggested Readings**

- Barber SA. 1995. Soil Nutrient Bioavailability. John Wiley & Sons.
- Barker V Allen & Pilbeam David J. 2007. Handbook of Plant Nutrition. CRC / Taylor & Francis.
- Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Educ.
- Cooke GW. 1979. The Control of Soil Fertility. Crossby Lockwood & Sons.
- Epstein E. 1987. Mineral Nutrition of Plants - Principles and Perspectives. International Potash Institute, Switzerland.
- Kabata- Pendias Alina 2001. Trace Elements in Soils and Plants. CRC / Taylor & Francis.
- Kannaiyan S, Kumar K & Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ. Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991.
- Micronutrients in Agriculture. 2nd Ed. Soil Science Society of America, Madison.
- Prasad R & Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.
- Stevenson FJ & Cole MA. 1999. Cycles of Soil Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.
- Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science Society of America, Madison. 101
- Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers*. 5th Ed. Macmillan Publ.
- Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

**SOILS 605      Biochemistry of Soil Organic Matter<sup>2+0</sup>**

**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 103

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.





**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 a 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. 3<sup>rd</sup> 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. 2<sup>nd</sup> 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. 2<sup>nd</sup> 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/course/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 Compulsory Course***

**PGS 501 Library and Information Services1(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; ere sources access methods.

**PGS 504 Basic Concepts in Laboratory Techniques1(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 vacuumpets; 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; Neutralization 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, sand bath, water bath, oil bath; 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 Agriculture Research, Research Ethics and Rural Development Program's1(1+0)**

**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*.

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

**PGS 506 Disaster Management 1(1+0)**

**Objective** 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.

**PGS 502 Technical Writing and Communications Skills 1(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. 14<sup>th</sup> 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 & Dharmija 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 management in Agriculture1(1+0)**

#### **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.

**AGRONOMY**

**List of Journals**

Agriculture, Ecosystems and Environment  
Advances in Agronomy  
Agricultural Systems  
Agricultural Water Management  
Agronomy Journal  
Annual Review of Plant Physiology  
Applied Ecology and Environment Research  
Australian Journal of Agricultural Research  
Australian Journal of Experimental Agriculture  
Crop Protection  
Environment and Ecology  
European Journal of Agronomy  
Fertilizer Research  
Field Crops Research  
Indian Journal of Agricultural Sciences  
Indian Journal of Agronomy  
Indian Journal of Ecology  
Indian Journal of Weed Science  
Irrigation Science  
Japanese Journal of Crop Science  
Journal of Agronomy  
JNKVV Research Journal  
Journal of Agricultural Science Cambridge  
Journal of Applied Ecology  
Journal of Experimental Botany  
Journal of Farming Systems Research  
Journal of Range Management  
Journal of Sustainable Agriculture  
Netherlands Journal of Agricultural Sciences  
Nutrient Cycling in Agroecosystems  
Pesticide Biochemistry and Physiology  
Plant and Soil  
Swedish Journal of Agricultural Research  
Tropical Agriculture  
Soil and Tillage Research  
Plant Production Science

**Suggested Broad Topics for Master and  
Doctoral Research**

Crop diversification under different agricultural situations  
Development of farming systems for marginal, small and other farmers  
Agricultural information at door step/click of mouse  
Farm-specific nutrient management  
Weed management in different cropping/farming systems  
Nutrient studies in different cropping/farming systems  
Biodiversity of farming systems for conservation  
Organic farming systems for different regions  
Modeling for different crop situations  
Conservation agriculture for yield sustainability  
Role of edaphic factors on weeds proliferation and management  
Implications of global warming on weed growth and herbicide behaviour  
Ecological implications of using thresholds for weed management  
Effect of cultivation practices and herbicides on weed flora shift  
GM crops and weed management strategies  
Weed management under reduced moisture regime in major summer/kharif crops  
Avoidance of herbicide resistance using IWM