

DEPARTMENT OF HORTICULTURE

Name of the Programme M.Sc. (Ag) Vegetable Science

Courses offer in Master Degree programme

Group	Number	Title of Course	Credit
<b>Major</b>	1	VSC 501 Production technology of cool season vegetable crops	3(2+1)
	2	VSC 508 Organic Vegetable production Technology	2(1+1)
	3	VSC 507 Production technology of under exploited veg.	3(2+1)
	4	VSC 502 Production technology of warm season vegetable crops	3(2+1)
	5	VSC 503 Breeding of vegetable crops	3(2+1)
	6	VSC 504 Growth and development of vegetable crops	3(2+1)
	7	VSC 509 Fundamentals of processing of vegetable	3(2+1)
<b>Total</b>			<b>20 (13+7)</b>
<b>Seminar</b>		VSC 591 Credit Seminar	<b>1(0+1)</b>
		VSC 599 Research	<b>20(0+20)</b>
<b>Minor</b>	1	PP 501 Principle of Plant Physiology	4(3+1)
	2	GP 503 Principle of Plant Breeding	3(2+1)
	3	PP 504 Hormonal regulation of plant growth and development	3(2+1)
<b>Total</b>			<b>10 (7+3)</b>
<b>Supporting</b>	1	STAT 511 Statistical Methods for Applied Sciences	4 (3+1)
	2	STAT 512 Experimental Designs	3 (2+1)
<b>Total</b>			<b>7(5+2)</b>
<b>Non-Credit Compulsory Course</b>	1.	PGS 501 Library and Information Services	1(0+1)
	2.	PGS 502 Technical Writing and Communications Skills	1(0+1)
	3.	PGS 503 Intellectual Property and its Management in Agriculture	1(1+0)
	4	PGS 504 Basic Concepts in Laboratory Techniques	1(0+1)
	5	PGS 505 Agril Res. Ethics and Rural Dev. Programs	1(1+0)
	6	PGS 506 Disaster Management	1(1+0)
	7	Human value and Professional Ethics	2(1+1)
<b>Total</b>			<b>8(4+4)</b>
<b>Grand total</b>			<b>66( 29+46)</b>

Name of the Programme M.Sc. (Horticulture) Vegetable Science

Semester wise distribution of courses

Course	Course Title	Code	Credits
<b>Semester I</b>			
<b>Major</b>	Production technology of cool season vegetable crops	VSC - 501	3(2+1)
	Organic Vegetable production Technology	VSC- 508	2(1+1)
	Production technology of under exploited veg.	VSC - 507	3(2+1)
<b>Minor</b>	Prin. of Plant Physiology	PP-501	4(3+1)
	Prin. Of Plant Breeding	GP 503	3(2+1)
<b>Supporting</b>	Statistical Methods for Applied Science	STAT 511	4(3 + 1)
<b>Compulsory NC</b>	Library and information services	PGS - 501	1(0 +1)
	Basic concepts in laboratory techniques	PGS – 504	1(0 +1)
	IPR & Its management in Agriculture	PGS - 503	1(1+0)
	Human Value & Professional Ethics	HVE	2(1+1)
<b>Semester II</b>			
<b>Major</b>	Production technology of warm season vegetable crops	VSC - 502	3(2 + 1)
	Breeding of vegetable crops	VSC - 503	3(2 + 1)
	Growth and development of vegetable crops	VSC - 504	3(2 + 1)
	Fundamentals of processing of vegetable	VSC - 509	3(2+1)
	Hormonal regulation of plant growth and development	PP- 504	3(2+1)
<b>Minor</b>	Experimental Designs	STAT 512	3(2+1)
<b>Supporting</b>	Agricultural Research, Research Ethics and Rural Development Programme	PGS–505	1(1+0)
	Disaster Management	PGS – 506	1(1+0)
	Tech. Writing & Communication skill	PGS - 502	1(0+1)
<b>Semester III</b>			
<b>Major</b>	Topic Seminar	VSC - 591	1(0+1)
	Master's Research	VSC – 599	10(0+10)
<b>Written Comprehensive examination</b>			
<b>Semester IV</b>			
<b>Major</b>	Master's Research	VSC - 599	10(0+10)

**VSC 501                      Production Technology of Cool Season Vegetable Crops                      2+1**

**Objective**                      To educate production technology of cool season vegetables.

**Theory**                      Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of

**UNIT I**                      Potato

**UNIT II**                      Cole crops cabbage, cauliflower, knoll kohlrabi, sprouting broccoli, Brussels sprout

**UNIT III**                      Root crops carrot, radish, turnip and beetroot

**UNIT IV**                      Bulb crops onion and garlic

**UNIT V**                      Peas and broad bean, green leafy cool season vegetables

**Practical**                      Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics

- Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides
- Study of physiological disorders; preparation of cropping scheme for commercial farms;
- Visit to commercial greenhouse/ polyhouse.

### **Suggested Readings**

- Bose TK & Som MG. (Eds.). 1986. Vegetable Crops in India. Naya Prokash.
- Bose TK, Som G & Kabir J. (Eds.). 2002. Vegetable Crops. Naya Prokash.
- Bose TK, Som MG & Kabir J. (Eds.). 1993. Vegetable Crops. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. Vegetable Crops. Vols. I-III. Naya Udyog.
- Chadha KL & Kalloo G. (Eds.). 1993-94. Advances in Horticulture Vols.V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. Hand Book of Horticulture. ICAR.
- Chauhan DVS. (Ed.). 1986. Vegetable Production in India. Ram Prasad & Sons.
- Decoteau DR. 2000. Vegetable Crops. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1951. Fundamentals of Horticulture. Blakiston Co.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops Production Technology. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency.
- Hazra P & Som MG. (Eds.). 1999. Technology for Vegetable Production and Improvement. Naya Prokash.
- Rana MK. 2008. Olericulture in India. Kalyani Publ.
- Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani Publ.
- Rubatzky VE & Yamaguchi M. 1997. World Vegetables Principles, Production and Nutritive Values. C & HI.
- Saini GS. 2001. A Text Book of Oleri and Flori Culture. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. Hand Book of Vegetable Science and Technology Production, Composition, Storage and Processing.
- Marcel Dekker. Shanmugavelu KG. 1989. Production Technology of Vegetable Crops. Oxford & IBH.
- Singh DK. 2007. Modern Vegetable Varieties and Production Technology. IBD Co.
- Singh SP. (Ed.). 1989. Production Technology of Vegetable Crops. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. (Eds.). 2004. Vegetables, Tuber Crops and Spices. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. Vegetable Crops. Tata McGraw- Hill.

**VSC 502                      Production Technology of Warm Season Vegetable Crops                      2+1**

**Objective**                      To teach production technology of warm season vegetables.

**Theory**                      Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of

**UNIT I**                      Tomato, eggplant, hot and sweet peppers

**UNIT II**                      Okra, beans, cowpea and clusterbean

**UNIT III**                      Cucurbitaceous crops

**UNIT IV**                      Tapioca and sweet potato

**UNIT V**                      Green leafy warm season vegetables

**Practical**                      Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics.

- Study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms.
- Experiments to demonstrate the role of mineral elements, physiological disorders.
- Plant growth substances and herbicides; seed extraction techniques.
- Identification of important pests and diseases and their control.
- Maturity standards; economics of warm season vegetable crops.

**Suggested Readings**

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. Vegetable Crops. Vols. I-III. NU  
Bose TK, Som MG & Kabir J. (Eds.). 2002. Vegetable Crops. Naya Prokash.  
Brown HD & Hutchison CS. Vegetable Science. JB Lippincott Co.  
Chadha KL & Kallou G. (Eds.). 1993-94. Advances in Horticulture. Vols. V-X. Malhotra Publ. House.  
Chadha KL. (Ed.). 2002. Hand Book of Horticulture. ICAR.  
Chauhan DVS. (Ed.). 1986. Vegetable Production in India. Ram Prasad & Sons.  
Decoteau DR. 2000. Vegetable Crops. Prentice Hall.  
Edmond JB, Musser AM & Andrews FS. 1964. Fundamentals of Horticulture. Blakiston Co  
Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops Production Technology. Vol. II. Kalyani.  
Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency.  
Kallou G & Singh K (Ed.). 2000. Emerging Scenario in Vegetable Research and Development. Research Periodicals & Book Publ. House.  
Palaniswamy & Peter KV. 2007. Tuber Crops. New India Publ. Agency.  
Rana MK. 2008. Olericulture in India. Kalyani.  
Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani.  
Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables Principles, Production and Nutritive Values. Saini GS.  
2001. A Text Book of Oleri and Flori Culture. Aman Publ. House.  
Salunkhe DK & Kadam SS. (Ed.). 1998. Hand Book of Vegetable Science and Technology Production, Composition, Storage and Processing.  
Marcel Dekker. Shanmugavelu KG. 1989. Production Technology of Vegetable Crops. Oxford & IBH.  
Singh DK. 2007. Modern Vegetable Varieties and Production Technology. IBD Co.33  
Singh NP, Bharadwaj AK, Kumar A & Singh KM. 2004. Modern Technology on Vegetable Production. IBD  
Singh SP. (Ed.). 1989. Production Technology of Vegetable Crops. Agril. Comm. Res. Centre.  
Thamburaj S & Singh N. 2004. Vegetables, Tuber Crops and Spices. ICAR.





- UNIT I** Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.
- UNIT II** Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables.
- UNIT III** Cytological level of various vegetable crops; descriptive keys for important vegetables.
- UNIT IV** Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

**Practical**

- Identification, description, classification and maintenance of vegetable species and varieties.
- Survey, collection of allied species and genera locally available;
- Preparation of keys to the species and varieties;
- Methods of preparation of herbarium and specimens.

**Suggested Readings**

- Chopra GL. 1968. Angiosperms - Systematics and Life Cycle. S. Nagin  
Dutta AC. 1986. A Class Book of Botany. Oxford Univ. Press.  
Pandey BP. 1999. Taxonomy of Angiosperm. S. Chand & Co.  
Peter KV & Pradeepkumar T. 2008. Genetics and Breeding of Vegetables. (Revised), ICAR.  
Soule J. 1985. Glossary for Horticultural Crops. John Wiley & Sons.  
Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS.  
2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II Vegetable Crops. NBPGR, New Delhi.  
Vasistha. 1998. Taxonomy of Angiosperm. Kalyani.  
Vincent ER & Yamaguchi M. 1997. World Vegetables. 2nd Ed. Chapman & Hall.

**VSC 507                      Production Technology of Underexploited**

**2+1**

**Objective  
Theory**

To educate production technology of underutilized vegetable crops.

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of

**UNIT I**

Asparagus, artichoke and leek

**UNIT II**

Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

**UNIT III**

Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.

**UNIT IV**

Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

**UNIT V**

Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

**Practical**

- Identification of seeds.
- Botanical description of plants;
- Layout and planting; cultural practices;
- Short-term experiments of underexploited vegetables.

**Suggested Readings**

Bhat KL. 2001. Minor Vegetables - Untapped Potential. Kalyani.

Indira P & Peter KV. 1984. Unexploited Tropical Vegetables. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. Underutilized and Underexploited Horticultural Crops. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables Principles, Production and Nutritive Values. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS.2001. Minimal Descriptors of Agri-Horticultural Crops. Part-IIVegetable Crops. NBPGR, New Delhi. 38



**VSC 508                      Organic Vegetable Production Technology                      1+1**

**Objective**                      To educate principles, concepts and production of organic farming in vegetable crops.

**Theory**

**UNIT I**                      Importance, principles, perspective, concept and component of organic production of vegetable crops.

**UNIT II**                      Organic production of vegetables crops, viz., solanaceous crops, cucurbits, cole crops, root and tuber crops.

**UNIT III**                      Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

**UNIT IV**                      Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavya, Biodynamics, preparation etc Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

**UNIT V**                      GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

**Practical**

- Method of preparation of compost, vermicomposting, biofertilizers, soil solarization.
- Bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production.
- Waster management, organic soil amendment for root disease, weed management in organic horticulture.
- Visit to organic fields and marketing centers.

**Suggested Readings**

Dahama AK. 2005. Organic Farming for Sustainable Agriculture. 2nd Ed. Agrobios.  
Gehlot G. 2005. Organic Farming; Standards, Accreditation Certification and Inspection. Agrobios.  
Palaniappan SP & Annadorai K. 2003. Organic Farming, Theory and Practice. Scientific Publ.  
Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008.  
Management of Horticultural Crops. New India Publ. Agency.  
Shivashankar K. 1997. Food Security in Harmony with Nature. 3rd IFOAMASIA,  
Scientific Conf.. 1- 4 December, 1997, UAS, Bangalore.

<b>VSC 509</b>	<b>Fundamentals of Processing of Vegetables</b>	<b>2+1</b>
<b>Theory</b>		
<b>UNIT I</b>	History of food preservation. Present status and future prospects of vegetable preservation industry in India.	
<b>UNIT II</b>	Spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms, food poisoning and their control measures. Role of microorganisms in food preservation.	
<b>UNIT III</b>	Raw materials for processing. Primary and minimal processing; processing equipments; Layout and establishment of processing industry, FPO licence. Importance of hygiene; Plant sanitation.	
<b>UNIT IV</b>	Quality assurance and quality control, TQM, GMP. Food standards-FPO, PFA, etc. Food laws and regulations.	
<b>UNIT V</b>	Food safety-Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.	
<b>UNIT VI</b>	Major value added products from vegetables.Utilization of by products of vegetable processing industry; Management of waste from processing factory.	
<b>UNIT VII</b>	Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.	
<b>Practical</b>		
	<ul style="list-style-type: none"><li>• Study of machinery and equipments used in processing of horticultural produce.</li><li>• Chemical analysis for nutritive value of fresh and processed vegetables.</li><li>• Study of different types of spoilages in fresh as well as processed horticultural produce.</li><li>• Classification and identification of spoilage organisms; Study of biochemical changes and enzymes associated with spoilage.</li><li>• Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables.</li><li>• Study of food standards – National, international, CODEX Alimentarius; Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.</li></ul>	

### **Suggested Readings**

- Arthey D & Dennis C. 1996. Vegetable Processing. Blackie/Springer- Verlag.
- Chadha DS. 2006. The Prevention of Food Adulteration Act. Confed. of Indian Industry.
- FAO. 1997. Fruit and Vegetable Processing. FAO.
- Frazier WC & Westhoff DC. 1995. Food Microbiology. 4th Ed. Tata McGraw Hill.
- Giridharilal GS, Siddappa & Tandon GL. 1986. Preservation of Fruits and Vegetables. ICAR.
- Gisela J. 1985. Sensory Evaluation of Food–Theory and Practices. Ellis Horwood.
- Mahindru SN. 2004. Food Safety Concepts and Reality. APH Publ. Corp.
- Ranganna S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed.
- Shapiro R. 1995. Nutrition Labeling Handbook. Marcel Dekker.
- Srivastava RP & Kumar S. 2003. Fruit and Vegetable Preservation Principles and Practices. 3rd Ed. IBD
- Verma LR & Joshi VK. 2000. Post-harvest Technology of Fruits and Vegetables Handling, Processing, Fermentation and Waste Management. Indus Publ. Co.

<b>PP 501</b>	<b>Principles of Plant Physiology</b>	<b>3+1</b>
<b>Objective</b>	To acquaint the students with the basic concepts of plant physiology and their application in agriculture.	
<b>Theory</b>		
<b>UNIT I</b>	Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions.	
<b>UNIT II</b>	Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells.	
<b>UNIT III</b>	Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorrhizal association on water uptake.	
<b>UNIT IV</b>	Water loss from plants-Energy balance-solar energy input-energy dissipation at crop canopy level-evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate.	
<b>UNIT V</b>	Stomata structure and function–mechanism of stomatal movement	

<b>STAT 511</b>	<b>Statistical Methods for Applied Sciences</b>	<b>3+1</b>
<b>Objective</b>	The student is exposed statistical methods and statistical inference to help them in understanding the concepts involved in data presentation, analysis and interpretation.	
<b>Theory</b>		
<b>UNIT I</b>	Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.	
<b>UNIT II</b>	Discrete and continuous probability 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.	
<b>UNIT III</b>	Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, 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.	
<b>UNIT IV</b>	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.	
<b>UNIT V</b>	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, $D^2$ -statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• 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.</li></ul>	

### 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://freestatistics.altervista.org/en/learning.php>.
- Electronic Statistics Text Book  
<http://www.statsoft.com/textbook/stathome.html>.

<b>STAT 512</b>	<b>Experimental Designs</b>	<b>2+1</b>
<b>Objective</b>	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.	
<b>Theory</b>		
<b>UNIT I</b>	Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.	
<b>UNIT II</b>	Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.	
<b>UNIT III</b>	Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	
<b>UNIT IV</b>	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.	
<b>UNIT V</b>	Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• 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.</li></ul>	

### Suggested Readings

- Cochran WG & Cox GM. 1957. Experimental Designs. 2<sup>nd</sup> 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).

**Non-Credit Compulsory Courses**

<b>PGS 501</b>	<b>Library and Information Services</b>	<b>1(0+1)</b>
<b>Objective</b>	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.	
<b>Practical</b>	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.	
<b>PGS 504</b>	<b>Basic Concepts in Laboratory Techniques</b>	<b>1(0+1)</b>
<b>Objective</b>	To acquaint the students about the basics of commonly used techniques in laboratory.	
<b>Practical</b>	Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; 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	
<b>Suggested Readings</b>		
Furr AK. 2000. <i>CRC Hand Book of Laboratory Safety</i> . CRC Press.		
Gabb MH & Latchem WE. 1968. <i>A Handbook of Laboratory Solutions</i> . Chemical Publ. Co.		
<b>PGS 505</b>	<b>Agriculture Research, Research Ethics and Rural Development Program's</b>	<b>1(1+0)</b>
<b>Objective</b>	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.	
<b>Theory</b>		
<b>UNIT I</b>	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. 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 management in Agriculture**

**1(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.