

**Faculty of Agriculture Science & Technology**

**Department of Horticulture**

**Study and Evaluation Scheme Of**

**M.Sc Horticulture**

**In**

**Vegetable Science**

**(Applicable w.e.f Academic Session 2022-23, till revised)**



**AKS UNIVERSITY, SATNA**

**Study and Evaluation Scheme**

\*\* The University Authorities reserve all the rights to make any additions/ deletions or changes/  
modifications to this syllabus as deemed necessary

**M.Sc. (Horticulture) in Vegetable Science**  
**Two years Master Degree Programme**  
**Session 2022-2024**

Requirement of the credit hours for award of the degree

<b>S.No.</b>	<b>Nature of Papers</b>	<b>Credit hours</b>
<b>1</b>	Major Courses	21
<b>2</b>	Minor Courses	11
<b>3</b>	Supporting Courses	06
<b>4</b>	Common Courses	05
<b>5</b>	Master's seminar	01
<b>6</b>	Master's research	30
	<b>Total Credit</b>	<b>74</b>

Major Courses: The subject (department) in which the students takes admission.

Minor Courses: The subject closely related to student's major subject. A suggested list of specified minor subject is given below.

Supporting Courses: The subject not related to the major subject. It could be any subject considered relevant student's research work.

Common Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 505) are of general nature and are compulsory for Master's programme.

**Master's programme  
M.Sc. (Horticulture) in Vegetable Science  
Semester-wise distribution of courses**

**Semester I**

S. No.	Course No.	Course Title	Credit hours	Sub-total
<b>(A)major</b>				
1.	VSC- 501	Production of Cool Season Vegetable Crops	3(2+1)	3
2.	VSC- 503	Growth and Development of Vegetable Crops	3(2+1)	3
3.	VSC- 510	Systematics of Vegetable Crops	2(1+1)	2
4.	VSC- 511	Organic Vegetable Production	2(1+1)	2
<b>Total</b>			<b>10(6+4)</b>	<b>10</b>
<b>(B) Minor</b>				
1.	FLS - 510	Protected Cultivation of Flower Crops	3(2+1)	3
2.	FLS - 508	Turfgrass Management	3(2+1)	3
<b>Total</b>			<b>6(4+2)</b>	<b>6</b>
<b>(C) Basic Supporting Courses</b>				
1.	STAT-502	Statistical Methods for Applied Science	4(3+1)	4
<b>Total</b>			<b>4(3+1)</b>	<b>4</b>
<b>(D) Common Course</b>				
1.	PGS 501	Library and Information Services	1(0+1)	1
2.	PGS 502	Technical Writing and Communication Skills	1(0+1)	1
<b>Grand Total</b>			<b>22(13+9)</b>	<b>22</b>

## Semester II

S. No.	Course No.	Course Title	Credit hours	Sub-total
<b>(A)major</b>				
1.	VSC- 502	Production of Warm Season Vegetable Crops	3(2+1)	3
2.	VSC- 504	Principles of Vegetable Breeding	3(3+0)	3
3.	VSC- 507	Protected Cultivation of Vegetable Crops	2(1+1)	2
4.	VSC- 509	Production of Underutilized Vegetable Crops	3(2+1)	3
<b>Total</b>			<b>11(8+3)</b>	<b>11</b>
<b>(B) Minor</b>				
1.	FLS - 507	Nursery Management for Ornamental Plants	3(2+1)	3
2.	FLS - 506	Indoor Plants and Interiorscaping	2(1+1)	2
<b>Total</b>			<b>5(3+2)</b>	<b>5</b>
<b>(C) Basic Supporting Courses</b>				
1.	STAT-511	Experimental Design	3(2+1)	3
<b>Total</b>			<b>3(2+1)</b>	<b>3</b>
<b>(D) Common Course</b>				
1.	PGS 503	Intellectual Property and Its Management in Agriculture	1(1+0)	1
2.	PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)	1
<b>Grand Total</b>			<b>21(13+8)</b>	<b>21</b>

## Semester III

### A.

Course Code	Course Title	Credit hours
VSC- 591	Seminar	1(0+1)
	Thesis/Research	15

### B. Common Course

Course Code	Course Title	Credit hours
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)

## Semester IV

Course Code	Course Title	Credit hours
	Thesis/Research	15

## Course Contents

### M.Sc. (Hort.) in Vegetable Science I Semester

#### Course Title: Production of Cool Season Vegetable Crops VSC 501 (2+1)

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of crops.

#### Unit I

Bulb and tuber crops—Onion, garlic and potato.

#### Unit II

*Cole crops*—Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale.

#### Unit III

*Root crops*—Carrot, radish, turnip and beetroot.

#### Unit IV

*Peas and beans*—Garden peas and broad bean.

#### Unit V

*Leafy vegetables*—Beet leaf, fenugreek, coriander and lettuce.

#### Practical

- Scientific raising of nursery and seed treatment;
- Sowing, transplanting, vegetable grafting;
- Description of commercial varieties and hybrids;
- Demonstration on methods of irrigation, fertilizers and micronutrients application;
- Mulching practices, weed management;
- Use of plant growth substances in warm season vegetable crops;
- Study of nutritional and physiological disorders;
- Studies on hydroponics, aeroponics and other soilless culture;
- Identification of important pest and diseases and their control;
- Preparation of cropping scheme for commercial farms;
- Visit to commercial farm, greenhouse/ polyhouses;
- Visit to vegetable market;
- Analysis of benefit to cost ratio.

## Suggested Reading

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable crops*. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable crops*. Naya prokash.
- Chadha KL and 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 and sons.
- Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable crops: production technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable crops*. New India publ. agency.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. *Varieties of vegetable crops in India*, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- Hazra P. 2016. *Vegetable science*. 2<sup>nd</sup>edn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. *Modern technology for vegetable production*, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. *Olericulture in India*. Kalyani Publishers, New Delhi.
- Rana MK. 2008. *Scientific cultivation of vegetables*. Kalyani Publishers, New Delhi.
- Rubatzky VE and Yamaguchi M. (Eds.). 1997. *World vegetables: principles, production and nutritive values*. Chapman and Hall.
- Saini GS. 2001. *A text book of oleri and flori culture*. Aman publishing house.
- Salunkhe DK and 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 and IBH.
- Singh DK. 2007. *Modern vegetable varieties and production technology*. International bookdistributing Co.
- Singh SP. (Ed.). 1989. *Production technology of vegetable crops*. Agril. comm. res. centre. Thamburaj S and Singh N. (Eds.). 2004. *Vegetables, tuber crops and spices*. ICAR. Thompson HC and Kelly WC. (Eds.). 1978. *Vegetable crops*. Tata McGraw-Hill.

## **Course Title : Growth and Development of Vegetable Crops VSC – 503 (2+1)**

### **Theory**

#### **Unit I**

*Introduction and phytohormones*—Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.

#### **Unit II**

*Physiology of dormancy and germination*—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscisic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

#### **Unit III**

*Abiotic factors*—Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance.

#### **Unit IV**

*Fruit physiology*—Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

#### **Unit V**

*Morphogenesis and tissue culture*—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.

### **Practical**

- Preparation of plant growth regulator's solutions and their application;
- Experiments in breaking and induction of dormancy by chemicals;
- Induction of parthenocarpy and fruit ripening;
- Application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables;
- Growth analysis techniques in vegetable crops;
- Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

### **Suggested Reading**

Bleasdale JKA. 1984. *Plant physiology in relation to horticulture* (2<sup>nd</sup> Edition) MacMillan. Gupta US. Eds. 1978. *Crop physiology*. Oxford and IBH, New Delhi.

- Kaloo G. 2017. *Vegetable grafting: Principles and practices*. CAB International
- Krishnamoorti HN. 1981. *Application growth substances and their uses in agriculture*. Tata McGraw Hill, New Delhi.
- Leopold AC and Kriedemann PE. 1981. *Plant growth and development*, Tata McGraw-Hill, New Delhi.
- Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- Peter KV. (Eds). 2008. *Basics of horticulture*. New India publication agency, New Delhi.
- Rana MK. 2011. *Physio-biochemistry and Biotechnology of Vegetables*. New India Publishing Agency, Pritam Pura, New Delhi.
- Saini *et al.* (Eds.). 2001. *Laboratory manual of analytical techniques in horticulture*. Agrobios, Jodhpur.
- Wien HC. (Eds.). 1997. *The physiology of vegetable crops*. CAB International.

## **Course Title: Systematics of Vegetable Crops VSC – 510 (1+1)**

### **Theory**

#### **Unit I**

*Significance of systematic*—Significance of systematics and crop diversity in vegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops

#### **Unit II**

*Origin and evolution*—Origin, history, evolution and distribution of vegetable crops

#### **Unit III**

*Botanical and morphological description*—Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram; Morphological description of all parts of vegetables

#### **Unit IV**

*Cytology*—Cytological level of various vegetable crops with descriptive keys

#### **Unit V**

*Molecular markers*—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 Reading**

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 and Co

Peter KV and Pradeepkumar T. 2008. *Genetics and breeding of vegetables*. (Revised), ICAR. Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.

Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables* Volume II. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p.

Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables* Volume III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p.

Simmonds NW and Smartt J. 1995. *Evolution of crop plants*. Wiley-Blackwell. Soule J. 1985. *Glossary for Horticultural Crops*. John Wiley and Sons.

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M and Dhillon BS. 2001. *Minimal descriptors of agri-horticultural crops*. Part-II: Vegetable Crops. NBPGR, New Delhi.

Vasistha. 1998. *Taxonomy of angiosperm*. Kalyani Publishers, New Delhi.

Vincent ER and Yamaguchi M. 1997. *World vegetables*. 2nd Ed. Chapman and Hall.

## **Course Title: Organic Vegetable Production VSC – 511 (1+1)**

### **Theory**

#### **Unit I**

*Importance and principles*—Importance, principles, perspective, concepts and components of organic farming in vegetable crops

#### **Unit II**

*Organic production of vegetables*—Organic production of vegetable crops, viz., Solanaceous, Cucurbitaceous, Cole, root and tuber crops

#### **Unit III**

*Managing soil fertility*—Managing soil fertility, mulching, raising green manure crops, weed management in organic farming system; Crop rotation in organic production; Processing and quality control of organic vegetable produce

#### **Unit IV**

*Composting methods*—Indigenous methods of composting, Panchyagavya, Biodynamics preparations and their application; ITKs in organic vegetable farming; Role of botanicals and bio-control agents in the management of pests and diseases in vegetable crops

#### **Unit V**

*Certification and export*—Techniques of natural vegetable farming, GAP and GMP-certification of organic products; Export- opportunity and challenges

### **Practical**

- Methods of preparation and use of compost, vermicompost, biofertilizers and biopesticides;
- Soil solarisation;
- Use of green manures;
- Waste management; Organic soil amendments in organic production of vegetable crops;
- Weed, pest and disease management in organic vegetable production;
- Visit to organic fields and marketing centres.

### **Suggested Reading**

Dahama AK. 2005. Organic farming for sustainable agriculture. 2nd Ed. Agrobios.

Gehlot G. 2005. Organic farming; standards, accreditation certification and inspection. Agrobios.

Palaniappan SP and Annadorai K. 2003. Organic farming, theory and practice. Scientific publ.

Pradeepkumar T, Suma B, Jyothibhaskar and 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, UAS, Bangalore.

## **Course Title: Protected Cultivation of Flower Crops FLS – 510 (2+1)**

### **Theory**

#### **Block 1: Principles and types**

**Unit I:** Prospects and types of protected structures: Prospects of protected floriculture in India; Types of protected structures – Glasshouse/ polyhouse, shadenet houses, mist chambers, lath houses, orchidarium, fernery, rain shelters, etc.

**Unit II:** Principles and design: Principles of designing and erection of protected structures; Low cost/ Medium cost/ High cost structures; Location specific designs; Structural components; Suitable flower and foliage plants for protected cultivation.

#### **Block 2: Growing environment**

**Unit I:** Control of environment: Microclimate management and manipulation of temperature, light, humidity, air and CO<sub>2</sub>; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation, water harvesting.

**Unit II:** Intercultural operations and crop regulation: Containers and substrates, media, soil decontamination, layout of drip and fertigation system, water and nutrient management, IPM and IDM, Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

**Unit III:** Automation and standards: Automation in greenhouses, sensors, solar greenhouses and retractable greenhouses, GAP/ Flower labels, Export standards, EXIM policy, APEDA regulations for export, Non-tariff barriers.

### **Crops**

Rose, Chrysanthemum, Carnation, Gerbera, Orchids, Anthuriums, Liliium, Limonium, Lisianthus, heliconia, Cala lily, Alstromeria, etc.

### **Practical**

- Study of various protected structures (1);
- Design, layout and erection of different types of structures (2);
- Practices in preparatory operations, growing media, soil decontamination techniques (2);
- Microclimate management (2);
- Practices in drip and fertigation techniques, special horticultural practices (2);
- Determination of harvest indices and harvesting methods (1);
- Postharvest handling, packing methods (1);
- Economics of cultivation, Project preparation (2);
- Project Financing guidelines (1);
- Visit to commercial greenhouses (2).

### **Suggested Reading**

- Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
- Bose TK, Maiti RG, Dhua RS and Das P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata India.
- Bose TK and Yadav LP. 1989. Commercial Flowers. Naya Prokash, Kolkata, India.
- Chadha KL and Bhattacharjee SK. 1995. Advances in Horticulture: Ornamental Plants. Vol. XII, Parts 1 & 2. pp.533 and pp.574. Malhotra Publ. House, New Delhi, India.
- Lauria A and Victor HR. 2001. Floriculture-Fundamentals and Practices. Agrobios Publ., Jodhpur.
- Nelson PV. 2011. Green House Operation and Management. Pearson Publ. 7th edition, pp. 624.
- Prasad S and Kumar U. 2003. Commercial Floriculture. Agrobios Publ., Jodhpur.
- Randhawa GS and Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.
- Reddy S, Janakiram T, Balaji T, Kulkarni S and Misra RL. 2007. Hi- Tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi, India

## **Course Title: Turfgrass Management FLS – 508 (2+1)**

### **Theory**

#### **Block 1: Turf industry and turf grasses**

**Unit I:** Prospects and basic requirement: History, present status and prospects of turf industry; basic requirements, site selection and evaluation, concepts of quality of soil pertaining to turf grass establishment, criteria for evaluation of turf quality.

**Unit II:** Types of turf grasses: Types, species, varieties, important breeders, grasses for different locations and conditions and their compatible groupings as per climatic conditions; Turfing for roof gardens.

**Unit III:** Operations and management: Preparatory operations; Turf establishment methods such as seeding, sprigging/ dibbling, plugging, sodding/ turfing, turf plastering, instant turfing (portable), hydroseeding, synthetic turfing. Turf management – Irrigation, drainage, nutrition, and special practices like aerating, rolling, coring, dethatching, verticutting, soil top dressing, use of plant growth regulators and micronutrients, Turf mowing – mowing equipments, techniques to Minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, standards for turf, use of recycled water, etc.

#### **Block 2: Turf for different grounds**

**Unit I:** Making of different sports arenas: Establishment and maintenance of turfs for playgrounds, viz., golf, football, hockey, cricket, tennis, rugby, residential and public parks, turfing of Govt. and Corporate office gardens, event specific preparation, turf colourants.

**Unit II:** Automation: Exposure to different tools, gadgets, machinery used in turf industry.

### **Practical**

- Identification of turf grasses and turf machinery (1);
- Soil preparation, turf establishment methods, provision of drainage (2);
- Layout of macro and micro irrigation systems (1);
- Water and nutrient management (2);
- Special practices – mowing, raking, rolling, soil top dressing, weed management (2);
- Biotic and abiotic stress management (2);
- Project preparation for turf establishment (2);
- Visit to parks, model cricket grounds and golf courses, airports, corporates, Govt. organizations (2);
- Rejuvenation of lawns (1);
- Turf economics (1).

### **Suggested Reading**

Aldous D. 1999. International Turf Management Handbook. CRC Press. pp.368.

Beard JB. 1972. Turf Grass Science and Culture. Pearson. 1st edition, pp. 672.

Chawla SL, Patil S, Patel MA, Patel RB and Patel RM. 2013. Turf grass Management. Published by NAU, Navsari.

Emmons R. 2007. Turf grass Science and Management. Cengage Learning Publ. 4th edition, pp. 592.

Nick-Christians. 2011. Fundamentals of Turf grass Management. Wiley; 4th Edition, pp. 424.

Turgeon AJ. 1980. Turf grass Management. Reston Publ. Inc.

## **Course Title: Statistical Methods for Applied Sciences STAT – 502 (3+1)**

### **Theory**

#### **Unit I**

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.

#### **Unit III**

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

#### **Unit IV**

Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test.

#### **Unit V**

Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

#### **Practical**

- Exploratory data analysis, 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 Correlation and regression analysis, fitting of Linear and Quadratic Model.
- Non-parametric tests. ANOVA: One way, Two Way, SRS.

#### **Suggested Reading**

Goon A.M, Gupta M.K and Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.

Goon A.M, Gupta M.K. and Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.

Hoel P.G. 1971. *Introduction to Mathematical Statistics*. John Wiley.

Hogg R.V and Craig T.T. 1978. *Introduction to Mathematical Statistics*. Macmillan.

Morrison D.F. 1976. *Multivariate Statistical Methods*. McGraw Hill.

Hogg RV, McKean JW, Craig AT. 2012. *Introduction to Mathematical Statistics* 7th Edition.

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

**Course Title: Library and Information Services PGS – 501 (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.

## **Course Title: Technical Writing and Communications Skills PGS – 502 (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**

- Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
- Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary*. 1995.
- Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
- Holt, Rinehart and 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*.
- Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
- Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

## Course Contents

## M.Sc. (Hort.) in Vegetable Science II Semester

### Course Title: Production of Warm Season Vegetable Crops VSC – 502 (2+1)

#### Theory

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery including grafting technique, sowing/ planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices namely hydroponics, aeroponics, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marking), pest and disease management and economics of crops.

#### Unit I

*Fruit vegetables*—Tomato, brinjal, hot pepper, sweet pepper and okra.

#### Unit II

*Beans*—French bean, Indian bean (Sem), cluster bean and cowpea.

#### Unit III

*Cucurbits*—Cucumber, melons, gourds, pumpkin and squashes.

#### Unit IV

*Tuber crops*—Sweet potato, elephant foot yam, tapioca, taro and yam.

#### Unit V

*Leafy vegetables*—Amaranth and drumstick.

#### Practical

- Scientific raising of nursery and seed treatment;
- Sowing, transplanting, vegetable grafting;
- Description of commercial varieties and hybrids;
- Demonstration on methods of irrigation, fertilizers and micronutrients application;
- Mulching practices, weed management;
- Use of plant growth substances in warm season vegetable crops;
- Study of nutritional and physiological disorders;
- Studies on hydroponics, aeroponics and other soilless culture;
- Identification of important pest and diseases and their control;
- Preparation of cropping scheme for commercial farms;
- Visit to commercial farm, greenhouse/ polyhouses;
- Visit to vegetable market;
- Analysis of benefit to cost ratio.

#### Suggested Readings

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable crops*. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable crops*. Naya prokash.
- Chadha KL and 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 and sons.
- Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable crops: production technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable crops*. New India publ. agency.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. *Varieties of vegetable crops in India*, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- Hazra P. 2016. *Vegetable science*. 2<sup>nd</sup>edn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. *Modern technology for vegetable production*, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. *Olericulture in India*. Kalyani Publishers, New Delhi.
- Rana MK. 2008. *Scientific cultivation of vegetables*. Kalyani Publishers, New Delhi.
- Rubatzky VE and Yamaguchi M. (Eds.). 1997. *World vegetables: principles, production and nutritive values*. Chapman and Hall.
- Saini GS. 2001. *A text book of oleri and flori culture*. Aman publishing house.
- Salunkhe DK and 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 and IBH.
- Singh DK. 2007. *Modern vegetable varieties and production technology*. International bookdistributing Co.
- Singh SP. (Ed.). 1989. *Production technology of vegetable crops*. Agril. comm. res. centre. Thamburaj S and Singh N. (Eds.). 2004. *Vegetables, tuber crops and spices*. ICAR. Thompson HC and Kelly WC. (Eds.). 1978. *Vegetable crops*. Tata McGraw-Hill.

**Course Title: Principles of Vegetable Breeding VSC – 504 (2+1)**

## **Theory**

### **Unit I**

*Importance and history*- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding.

### **Unit II**

*Selection procedures*- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).

### **Unit III**

*Heterosis breeding*- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms.

### **Unit IV**

*Mutation and Polyploidy breeding*; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment.

### **Unit V**

*Ideotype breeding*- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of *In-vitro* and molecular techniques in vegetable improvement.

## **Practical**

- Floral biology and pollination behaviour of different vegetables;
- Techniques of selfing and crossing of different vegetables, viz., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc.;
- Breeding system and handling of filial generations of different vegetables;
- Exposure to biotechnological lab practices;
- Visit to breeding farms.

## **Suggested Reading**

Allard RW. 1960. *Principle of plant breeding*. John Willey and Sons, USA.

Kaloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, Fl, USA.

Kole CR. 2007. *Genome mapping and molecular breeding in plants-vegetables*. Springer, USA.

Peter KV and Pradeep Kumar T. 1998. *Genetics and breeding of vegetables*. ICAR, New Delhi, p.488.

Prohens J and Nuez F. 2007. *Handbook of plant breeding-vegetables* (Vol I and II). Springer, USA.

Singh BD. 2007. *Plant breeding- principles and methods* (8th edn.). Kalyani Publishers, New Delhi.

Singh Ram J. 2007. Genetic resources, chromosome engineering, and crop improvement- vegetable crops (Vol. 3). CRC Press, Fl, USA.

**Course Title: Protected Cultivation of Vegetable Crops VSC – 507 (2+1)**

## **Theory**

### **Unit I**

*Scope and importance-* Concept, scope and importance of protected cultivation of vegetable crops; Principles, design, orientation of structure, low and high cost polyhouses/ greenhouse structures.

### **Unit II**

*Types of protected structure-* Classification and types of protected structures- greenhouse/ polyhouses, plastic-non plastic low tunnels, plastic walk in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rain shelters, NVP, climate control greenhouses, hydroponics and aeroponics; Soil and soilless media for bed preparation; Design and installation of drip irrigation and fertigation system.

### **Unit III**

*Abiotic factors-* Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables.

### **Unit IV**

*Nursery raising-* High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation.

### **Unit V**

*Cultivation of crops-* Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures.

### **Unit VI**

*Solutions to problems-* Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production.

## **Practical**

- Study of various types of protected structure;
- Study of different methods to control temperature, carbon dioxide and light;
- Study of different types of growing media, training and pruning systems in greenhouse crops;
- Study of fertigation and nutrient management under protected structures;
- Study of insect pests and diseases in greenhouse and its control;
- Use of protected structures in hybrid seed production of vegetables;
- Economics of protected cultivation (Any one crop);
- Visit to established green/ polyhouses/ shade net houses in the region.

## **Suggested Reading**

- Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture*. Malhotra Pub. House. Chandra S and Som V. 2000. *Cultivating vegetables in green house*. Indian horticulture 45:17- 18.
- Kaloo G and Singh K. (Eds.). 2000. *Emerging scenario in vegetable research and development*. Research periodicals and Book publ. house.
- Parvatha RP. 2016. *Sustainable crop protection under protected cultivation*. E-Book Springer.
- Prasad S and Kumar U. 2005. *Greenhouse management for horticultural crops*. 2<sup>nd</sup> Ed. Agrobios.
- Resh HM. 2012. *Hydroponic food production*. 7<sup>th</sup> Edn. CRC Press.
- Singh B. 2005. *Protected cultivation of vegetable crops*. Kalyani publishers, New Delhi
- Singh DK and Peter KV. 2014. *Protected cultivation of horticultural crops* (1<sup>st</sup> Edition) New India publishing agency, New Delhi.
- Singh S, Singh B and Sabir N. 2014. *Advances in protected cultivation*. New India publishing agency, New Delhi.
- Tiwari GN. 2003. *Green house technology for controlled environment*. Narosa publ. house.

## **Theory**

Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post harvest management of:.

### **Unit I**

*Stem and bulb crops*—Asparagus, leek and chinese chive

### **Unit II**

*Cole and salad crops*—Red cabbage, chinese cabbage, kale, sweet corn and baby corn

### **Unit III**

*Leafy vegetables*—Celery, parsley, indian spinach (poi), spinach, chenopods, chekurmanis and indigenous vegetables of regional importance

### **Unit IV**

*Gourds and melons*—Sweet gourd, spine gourd, teasle gourd, round gourd, and little/ Ivy gourd, snake gourd, pointed gourd, kachri, long melon, snap melon and gherkin

### **Unit V**

*Yam and beans*—Elephant foot yam, yam, yam bean, lima bean and winged bean

## **Practical**

- Identification and botanical description of plants and varieties;
- Seed/ planting material;
- Production, lay out and method of planting;
- Important cultural operations;
- Identification of important pests and diseases and their control;
- Maturity standards and harvesting;
- Visit to local farms.

## **Suggested Reading**

Bhat KL. 2001. *Minor vegetables-untapped potential*. Kalyani publishers, New Delhi.

Indira P and Peter KV. 1984. *Unexploited tropical vegetables*. Kerala agricultural university, Kerala.

Pandey AK. 2011. *Aquatic vegetables*. Agrotech publisher academy, New Delhi.

Peter KV. (Eds.). 2007-08. *Underutilized and underexploited horticultural crops*. Vol.1-4, New India publishing agency, Lucknow.

Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.

Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables* Volume II and III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.

Rana MK. 2018. *Vegetable crop science*. CRC Press Taylor and Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742 ISBN: 978-1-1380-3521-8

Rubatzky VE and Yamaguchi M. 1997. *World vegetables: vegetable crops*. NBPGR, New Delhi.

## **Course Title: Nursery Management for Ornamental Plants FLS – 507 (2+1)**

### **Block 1: Nursery Industry and Propagation**

**Unit I:** Scenario of nursery industry and sexual propagation: Importance and present scenario and status of nursery industry in India and in the world, life cycles in plants, Propagation methods, Factors influencing seed germination of flower crops, dormancy, seed quality, packing, storage, certification, testing. Hormonal regulation of germination and seedling growth.

**Unit II:** Asexual propagation: Methods of asexual propagation, rooting of soft and hard wood cutting under mist. Role of Plant growth regulators. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principles and methods, budding and grafting – selection of elite mother plants. Stock, scion and inter stock, relationship – Incompatibility.

**Unit III:** Micro propagation: Micro-propagation – principles and concepts, commercial exploitation in flower crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micro grafting, meristem culture. Hardening, packing and transport of micro-propagules.

### **Block 2: Nursery Management**

**Unit I:** Growing structures: Growing structures like mist chambers, tunnels, lath house, net house, growing media types, soil less culture and containers. Automation in nursery management.

**Unit II:** Sanitary and phyto-sanitary issues: Nursery – types, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, PPV&FR act and Quarantine system in India. Important quarantine pests and diseases, sanitary and phyto-sanitary issues threats to nursery Industry.

**Unit III:** Standards: Nursery standards, Hi-tech nurseries, garden centers.

### **Practical**

- Anatomical studies in rooting of cutting and graft union (2);
- Identification and production of plug plants, seedlings and saplings (2);
- Preparation of growing media and use of PGRs (2);
- Practice of propagation through specialized structures cuttings, layering, budding and grafting
- Case studies (2);
- Micropropagation of ornamental crops and hardening (3);
- Visit to tissue culture labs and nurseries (2);
- Economics (1).

### **Suggested Reading**

Adriance GW and Brison FR. 2000. Propagation of Horticultural Plants. Biotech Books, New Delhi, India.

Bose TK, Mitra SK and Sadhu M K. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkata, India.

Chadha KL, Ravindran PL and Leela Sahijram. 2000. Biotechnology in Horticulture and Plantation Crops. Malhotra Publ. House, New Delhi, India.

Davies Fred T Jr., Geneve RL, Wilson SB, Hartmann HT and Kester DL. 2018. Hartmann and Kester's Plant Propagation: Principles and Practices. Pearson Publ. 9th Edition.

Peter KV. 2008. Basics of Horticulture. New India Publ. Agency, New Delhi, India.

Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency, New Delhi, India. pp. 251.

Singh SP. 1989. Mist Propagation. Metropolitan Book Co., New Delhi, India.

## **Course Title: Indoor Plants and Interiorscaping FLS – 506 (1+1)**

### **Theory**

**Block 1:** Scope, principles and operations

**Unit I:** Importance and scope: Importance and scope of indoor plants and Interiorscaping, Indoor plants and Indoor air quality.

**Unit II:** Classification and principles: Factors affecting growth, development and flowering of Indoor plants. Classification of indoor plants based on light, temperature, humidity and pollution tolerance, Description and cultivation of various indoor plants. Principles of Interiorscaping, Role in pollution mitigation.

**Unit III:** Cultural operations: Containers and substrates, preparation of growing media, propagation, training, grooming, nutrition, And management of disease, pests and weeds. Maintenance of plants including repotting, foliar nutrition, light exposure and plant rotation. Media standards, Nursery and Export standards for potted plants, Nursery standards.

**Block 2:** Presentations and marketing

**Unit I:** Special gardens: Special gardens including miniature gardens and plant stand. Presentations like dish, terrarium, bottle gardens, hanging baskets, window boxes and Bonsai.

**Unit II:** Vertical gardens: Vertical gardens- History, planting material, structures, containers, substrate, water and nutrient management, supplemental lighting.

**Unit III:** Marketing: Marketing channels, Business models including plant rentals.

### **Practical**

- Identification of important house plants (2);
- Media and containers (1);
- Propagation (1);
- Cultural operations, maintenance and economics of indoor plants (2);
- Models for Interiorscaping (2);
- Familiarization with different indoor gardens (2);
- Making of terrariums, bottle garden, dish garden and their economics (2);
- Making of vertical gardens and economics (2);
- Exposure visits (2).

### **Suggested Reading**

Barbara P. 2005. The Complete Houseplant Survival Manual. Storey Publ., New Adams.

Randhawa GS and Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.

Wallach C. 1995. Interior Decorating with Plants. McMillan Seed Production Co. Inc., New York.

## **Course Title: Experimental Designs STAT – 511 (2+1)**

### **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. Concept of confounding.

#### **Unit IV**

Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

### **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,
- Analysis with missing data,
- Split plot and strip plot designs.

### **Suggested Reading**

Cochran WG and Cox GM. 1957. *Experimental Designs*. 2<sup>nd</sup> Ed. John Wiley.

Dean AM and Voss D. 1999. *Design and Analysis of Experiments*. Springer.

Montgomery DC. 2012. *Design and Analysis of Experiments*, 8<sup>th</sup> Ed. John Wiley.

Federer WT. 1985. *Experimental Designs*. MacMillan.

Fisher RA. 1953. *Design and Analysis of Experiments*. Oliver & Boyd.

Nigam AK and 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.

**Course Title: Intellectual Property and its Management in Agriculture PGS – 503  
(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 and 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 and Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M and 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; The Biological Diversity Act, 2002.

**Course Title: Basic Concepts in Laboratory Techniques PGS – 504 (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 and Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

## **M.Sc. (Hort.) in Vegetable Science III Semester**

### **Course Title: Agricultural Research, Research Ethics and Rural Development Programmes (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 and 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.