

**Faculty of Agriculture Science & Technology**

**Department of Agriculture Science**

**Study and Evaluation Scheme**

**Of**

**M.Sc (Ag) Horticulture**

**(Vegetable Science)**

(Applicable w.e.f Academic Session 2015-17, till revised)



**AKS UNIVERSITY, SATNA**

**Study and Evaluation Scheme**

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**M. Sc. (Ag)**  
**(Two Year Master Degree Programme)**  
**Requirement of credit hours for award of the degree**

<b>S.No</b>	<b>Nature of courses</b>	<b>Credit hours</b>
<b>1</b>	<b>Major courses</b>	<b>21</b>
<b>2</b>	<b>Minor courses</b>	<b>09</b>
<b>3</b>	<b>Supporting courses</b>	<b>06</b>
<b>4</b>	<b>Master Seminar</b>	<b>01</b>
<b>5</b>	<b>Master Research</b>	<b>20</b>
	<b>Total credits</b>	<b>57</b>

Major Subject: The subject (Department/Discipline) in which a student takes admission

Minor Subject: The subject closely related to a student's major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work or necessary for building his overall competence.

Non-Credit compulsory Courses: Six courses (PGS 1 –PGS 6) are of general nature and are compulsory

**Master's programme**  
**M. Sc.(Ag) Horticulture(VEGETABLE SCIENCE)**  
**Semester-wise distribution of courses**

**First Semester**

<b>A. Major courses*</b>			
<b>S.No.</b>	<b>Courses Code</b>	<b>Title of Course</b>	<b>Credit hours</b>
1	VSC 501	Production technology of cool season vegetable crops	3(2+1)
2	VSC 504	Growth and development of vegetable crops	3(2+1)
3	VSC 506	Systematic of vegetable crops	2(1+1)
4	VSC 508	Organic vegetable production technology	3(2+1)
		Total	11(7+4)
<b>B. Minor courses**</b>			
1	VSC 604	Biotechnology of vegetable crops	3(2+1)
2	VSC 505	Seed technology of vegetable crops and seed certification	3(2+1)
		Total	6 (4+2)
<b>C. Supporting courses***</b>			
1	STAT 511	Statistical methods in applied Science	3(2+1)
		Total	3(2+1)
<b>D. Non credit course</b>			
1	PGS 502	Technical Writing and communication skill	N.C.
2	PGS 503	Intellectual Property and Its management in Agriculture	N.C.
		Grand Total	20

**Second semester**

<b>A. Major courses*</b>			
<b>S.No</b>	<b>Courses Code</b>	<b>Title of Course</b>	<b>Credit hours</b>
1	VSC 502	Production technology of warm season vegetable crops	3(2+1)
2	VSC 503	Breeding of vegetable crops	3(2+1)
3	VSC 509	Fundamentals and processing of vegetable crops	2(1+1)
4	VSC 507	Production technology of underexploited vegetable crops	2(1+1)
		Total	10(6+4)
<b>B. Minor courses**</b>			
1	VSC 606	Abiotic stress management in vegetable crops	3(2+1)
		Total	3(2+1)
<b>C. Supporting courses***</b>			
1	STAT 512	Experimental design	3(2+1)
		Total	3(2+1)
<b>D. Non credit course</b>			
1	PGS 504	Library and information services	N.C.
2	PGS 501	Basic Concepts in Laboratory Techniques	N.C.
		Grand Total	16

**Third Semester**

<b>A. Major courses*</b>			
<b>S.No</b>	<b>Courses Code</b>	<b>Title of Course</b>	<b>Credit hours</b>
1	VSC 591	Master Seminar	1(0+1)
2	VSC 599	Master's Research	10(0+10)
		Total	11 (1+10)
<b>B. Non Credit Course**</b>			
1	PGS 506	Disaster Management	N.C.
2	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	N.C.
		Grand Total	

**Fourth Semester**

<b>A. Major courses*</b>			
<b>S.No</b>	<b>Courses Code</b>	<b>Title of Course</b>	<b>Credit hours</b>
1	VSC 599	Master's Research Seminar	10(0+10)
		Total	10(0+10)

## PRODUCTION TECHNOLOGY OF COOL SEASON 2+1

### VEGETABLE CROPS

#### 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.

31 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. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall. Saini GS. 2001. *A Text Book of Olericulture and Floriculture*. 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*. International Book Distributing 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 504 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS 2+1

### **Objective**

To teach the physiology of growth and development of vegetable crops.

### **Theory**

#### UNIT I

Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production.

#### UNIT II

Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscisic acid; Application of synthetic hormones, 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

Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance.

#### UNIT IV

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

Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

### **Practical**

Preparation of solutions of plant growth substances 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.

### **Suggested Readings**

Bleasdale JKA. 1984. *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan. Gupta US. (Ed.). 1978. *Crop Physiology*. Oxford & IBH. Krishnamoorti HN. 1981. *Application Plant Growth Substances and Their Uses in Agriculture*. Tata-McGraw Hill. Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency. Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001. *Laboratory Manual of Analytical Techniques in Horticulture*. Agrobios. Wien HC. (Ed.). 1997. *The Physiology of Vegetable Crops*. CABI.

## VSC 506 SYSTEMATICS OF VEGETABLE CROPS 1+1

### **Objective**

To teach morphological, cytological and molecular taxonomy of vegetable crops.

### **Theory**

#### 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 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. Nagin37 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 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, waste 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.



## VSC 604 BIOTECHNOLOGY IN VEGETABLE CROPS 2+1

### **Objective**

To teach advances in biotechnology for improvement of vegetable crops.

### **Theory**

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

#### UNIT I

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

#### UNIT II

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

#### UNIT III

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

#### UNIT IV

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

#### UNIT V

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

### **Practical**

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

### **Suggested Readings**

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

## VSC 505 SEED PRODUCTION TECHNOLOGY OF VEGETABLE 2+1 CROPS

### Objective

To educate principles and methods of quality seed and planting material production in vegetable crops and the recent trends in the certification, processing and storage of vegetable crops.

### Theory

#### UNIT I

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed;

seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

#### UNIT II

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology. Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

#### UNIT III

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification. Seed processing, study of seed processing equipments seed cleaning and

upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number.

#### UNIT IV

Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control. Seed testing; ISTA rules for testing, moisture, purity germination, vigortest, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy,

factors responsible for dormancy.

#### UNIT V

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

policy.

### Practical

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

### Suggested Readings

Agrawal PK & Dadlani M. 1992. *Techniques in Seed Science and Technology*. South Asian Publ. Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co. Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy. Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi. Rajan S & Baby L Markose 2007. *Propagation of Horticultural Crops*. New India Publ. Agency. Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ. Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH. Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ. Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable crops*

## STAT 511 STATISTICAL METHODS FOR APPLIED SCIENCES 3(2+1)

**Objective** It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

### Theory

#### UNIT I

Classification, tabulation and graphical, representation of data. Box-plot, Descriptive statistics. Exploratory data analysis;

#### UNIT II

Measures of central tendency- Mean, Median, Mode, Geometric mean, Harmonic mean.

#### UNIT III

Measures of Dispersion- Range, Quartile deviation, Mean deviation, Standard deviation.

#### UNIT IV

Theory of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions. Correlation and regression

#### UNIT V

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.

### Practical

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

### Suggested Readings

- ❖ Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.
- ❖ Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I
- ❖ Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I.
- ❖ Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.

## **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 knowledgebased economy.

### **Theory**

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

### **Suggested Readings**

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill. *Intellectual Property Rights: Key to New Wealth Generation. 2001*. NRDC & Aesthetic Technologies. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation. Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House. *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003*.

## **PGS 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*. 2nd Ed. Prentice Hall of India. Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

## VSC 502 PRODUCTION TECHNOLOGY OF WARM SEASON 2+1 VEGETABLE CROPS

### 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 & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog. Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash. Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co. 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. 1964. *Fundamentals of Horticulture*. Blakiston Co Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani. Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publ. Agency. Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash. Kalloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House. Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ. Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency. Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques*. 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*. Chapman & Hall. 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*. International Book Distributing Co. Singh NP, Bharadwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distributing Co. Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre. Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*. ICAR. Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

## VSC 503 BREEDING OF VEGETABLE CROPS 2+1

### Objective

To educate principles and practices adopted for breeding of vegetable crops.

### Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act.

#### UNIT I

Potato and tomato

#### UNIT II

Eggplant, hot pepper, sweet pepper and okra

#### UNIT III

Peas and beans, amaranth, chenopods and lettuce

#### UNIT IV

Gourds, melons, pumpkins and squashes

#### UNIT V

Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca

### Practical

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

### Suggested Readings

Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons. Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ. Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House. Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani. Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons. Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill. Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding-Principles and Prospects*. Chapman & Hall. Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press. Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency. Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ. Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region*. FAO. Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. Revised, ICAR. Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency. Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani. Simmonds NW. 1978. *Principles of Crop Improvement*. Longman. Singh BD. 1983. *Plant Breeding*. Kalyani. Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co. Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable*

## VSC 509 FUNDAMENTALS OF PROCESSING OF VEGETABLES 2+1

### **Objective**

To educate principles and practices of processing of vegetable crops.

### **Theory**

#### UNIT I

History of food preservation. Present status and future prospects of vegetable preservation industry in India.

#### UNIT II

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.

#### UNIT III

Raw materials for processing. Primary and minimal processing; processing equipments; Layout and establishment of processing industry, FPO licence. Importance of hygiene; Plant sanitation.

#### UNIT IV

Quality assurance and quality control, TQM, GMP. Food standards – FPO, PFA, etc. Food laws and regulations.

#### UNIT V

Food safety – Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.

#### UNIT VI

Major value added products from vegetables. Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.

#### UNIT VII

Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.

### **Practical**

Study of machinery and equipments used in processing of horticultural produce; Chemical analysis for nutritive value of fresh and processed vegetables; Study of different types of spoilages in fresh as well as processed horticultural produce; Classification and identification of spoilage organisms; Study of biochemical changes and enzymes associated with spoilage; Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables; Study of food standards – National, international, CODEX Alimentarius; Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.

### **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. Desrosier NW. 1977. *Elements and Technology*. AVI Publ. Co.

FAO. 1997. *Fruit and Vegetable Processing*. FAO. FAO. *CODEX Alimentarius: Joint FAO/WHO Food Standards Programme*. 2nd Ed. Vol. VB. *Tropical Fresh Fruits and Vegetables*. FAO. FAO. *Food Quality and Safety Systems – Training Manual on Food Hygiene and HACCP*. FAO. Fellow's P. 1988. *Food Processing Technology*. Ellis Horwood

International. 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. Graham HD. 1980. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw Hill. Shapiro R. 1995. *Nutrition Labeling Handbook*. Marcel Dekker. Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation: Principles and Practices*. 3rd Ed. International Book Distri. Co. Tressler & Joslyn MA. 1971. *Fruit and Vegetable Juice Processing Technology*. AVI Publ. Co. Verma LR & Joshi VK. 2000. *Post-harvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Ind



## VSC 507 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED 2+1

### VEGETABLE CROPS

#### Objective

To educate production technology of underutilized vegetable crops.

#### 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

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-II: *Vegetable Crops*. NBPGR, New Delhi.

## VSC 606 ABIOTIC STRESS MANAGEMENT IN VEGETABLE 2+1 CROPS

### **Objective**

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

### **Theory**

#### UNIT I

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

#### UNIT II

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

#### UNIT III

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

#### UNIT IV

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

#### UNIT V

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

### **Practical**

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

### **Suggested Readings**

Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios. Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel  
Decker. Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.

## **PGS 504: Basic Concepts in Laboratory Techniques 1(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 vial caps; 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 agrochemical 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.8. FMPE 503: Testing and Evaluation of Tractors and Farm Equipment

**PGS 501: Library and Information Services 1(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.

**STAT 512****Objective**

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

**Theory**

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

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

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

UNIT IV Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

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

**Practical**

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

**Suggested Readings**

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

## 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. 16 FMPE 595:

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## **PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES**

### **Objective**

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

### **UNIT I**

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

### **UNIT II**

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

### **UNIT III**

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

### **Suggested Readings**

- Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
- Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
- Singh K.. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.