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

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

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

#### A. Major courses*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSC 501</td>
<td>Production technology of cool season vegetable crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>2</td>
<td>VSC 504</td>
<td>Growth and development of vegetable crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>3</td>
<td>VSC 506</td>
<td>Systematic of vegetable crops</td>
<td>2(1+1)</td>
</tr>
<tr>
<td>4</td>
<td>VSC 508</td>
<td>Organic vegetable production technology</td>
<td>3(2+1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>11(7+4)</td>
</tr>
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</table>

#### B. Minor courses**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSC 604</td>
<td>Biotechnology of vegetable crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>2</td>
<td>VSC 505</td>
<td>Seed technology of vegetable crops and seed certification</td>
<td>3(2+1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>6 (4+2)</td>
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</tbody>
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#### C. Supporting courses***

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STAT 511</td>
<td>Statistical methods in applied Science</td>
<td>3(2+1)</td>
</tr>
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#### D. Non credit course

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
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<tbody>
<tr>
<td>1</td>
<td>PGS 502</td>
<td>Technical Writing and communication skill</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>PGS 503</td>
<td>Intellectual Property and Its management in Agriculture</td>
<td>N.C.</td>
</tr>
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<td>Grand Total</td>
<td>20</td>
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### Second Semester

#### A. Major courses*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSC 502</td>
<td>Production technology of warm season vegetable crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>2</td>
<td>VSC 503</td>
<td>Breeding of vegetable crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>3</td>
<td>VSC 509</td>
<td>Fundamentals and processing of vegetable crops</td>
<td>2(1+1)</td>
</tr>
<tr>
<td>4</td>
<td>VSC 507</td>
<td>Production technology of underexploited vegetable crops</td>
<td>2(1+1)</td>
</tr>
<tr>
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#### B. Minor courses**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSC 606</td>
<td>Abiotic stress management in vegetable crops</td>
<td>3(2+1)</td>
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<tr>
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<td>Total</td>
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</table>

#### C. Supporting courses***

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STAT 512</td>
<td>Experimental design</td>
<td>3(2+1)</td>
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<tr>
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<td>Total</td>
<td>3(2+1)</td>
</tr>
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</table>

#### D. Non credit course

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGS 504</td>
<td>Library and information services</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>PGS 501</td>
<td>Basic Concepts in Laboratory Techniques</td>
<td>N.C.</td>
</tr>
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### Third Semester

<table>
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<th>Title of Course</th>
<th>Credit hours</th>
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<tbody>
<tr>
<td>1</td>
<td>VSC 591</td>
<td>Master Seminar</td>
<td>1(0+1)</td>
</tr>
<tr>
<td>2</td>
<td>VSC 599</td>
<td>Master’s Research</td>
<td>10(0+10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>11 (1+10)</strong></td>
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</table>

#### B. Non Credit Course**

<table>
<thead>
<tr>
<th>S.No</th>
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<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGS 506</td>
<td>Disaster Management</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>PGS 505</td>
<td>Agricultural Research, Research Ethics and Rural Development Programmes</td>
<td>N.C.</td>
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</table>

**Grand Total**

### Fourth Semester

<table>
<thead>
<tr>
<th>S.No</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSC 599</td>
<td>Master’s Research Seminar</td>
<td>10(0+10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>10(0+10)</strong></td>
</tr>
</tbody>
</table>
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 kohl, 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
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
**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**
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

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

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

Suggested Readings
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

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
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, seedviability, 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
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
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
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
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


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

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
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
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
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 vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different 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
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; e-re 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
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 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
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
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.