M. Sc (Horticulture)
in
Fruit Science & Vegetable Science

Syllabi

As per recommendations from the Broad Subject Matter Area (BSMA)
Committees of Indian Council of Agricultural Research (ICAR)
& New Education Policy (NEP) 2020

DEPARTMENT OF HORTICULTURE AND
POST-HARVEST TECHNOLOGY
PALLI SIKSHA BHAVANA (INSTITUTE OF AGRICULTURE)
VISVA-BHARATI
SRINIKETAN
WEST BENGAL

Restructured and revised syllabi of PG Courses from Department of Horticulture and Post-Harvest Technology

M.Sc. (Horticulture) Fruit Science

Courses on Fruit Science

Course Code	Course Title	Credit hours
	Major Courses (20 Credits)	
FSC 501*	Tropical Fruit Production	2+1
FSC 502*	Sub-Tropical and Temperate Fruit Production	2+1
FSC 503*	Propagation and Nursery Management of Fruit Crops	2+1
FSC 504*	Breeding of Fruit Crops	2+1
FSC 505	Systematics of Fruit Crops	2+1
FSC 506	Canopy Management in Fruit Crops	1+1
FSC 507	Growth and Development of Fruit Crops	2+1
FSC 508	Nutrition of Fruit Crops	2+1
FSC 509	Biotechnology of Fruit Crops	2+1
FSC 510	Organic Fruit Culture	2+1
FSC 511	Export Oriented Fruit Production	2+1
FSC 512	Climate Change and Fruit Crops	1+0
FSC 513	Minor Fruit Production	2+1
FSC 591	Master's Seminar	0+1
FSC 599	Master's Research	0+30

*Compulsory among major courses for M.Sc. (Hort.) Fruit Science

M.Sc. (Horticulture) Vegetable Science

Courses on Vegetable Science

Course Code	Course Title	Credit hours
	Major Courses (20 Credits)	
VSC 501*	Production of Cool Season Vegetable Crops	2+1
VSC 502*	Production of Warm Season Vegetable Crops	2+1
VSC 503*	Growth and Development of Vegetable Crops	2+1
VSC 504*	Principles of Vegetable Breeding	2+1
VSC 505	Breeding of Self Pollinated Vegetable Crops	2+1
VSC 506	Breeding of Cross Pollinated Vegetable Crops	2+1
VSC 507	Protected Cultivation of Vegetable Crops	1+1
VSC 508	Seed Production of Vegetable Crops	2+1
VSC 509	Production of Underutilized Vegetable Crops	2+1
VSC 510	Systematics of Vegetable Crops	1+1
VSC 511	Organic Vegetable Production	1+1
VSC 512	Production of Spice Crops	2+1
VSC 513	Processing of Vegetables	1+1
VSC 514	Postharvest management of Vegetables	2+1
VSC 591	Master's Seminar	0+1
VSC 599	Master's Research	0+30

**Compulsory among major courses for M.Sc. (Hort.) Vegetable Science

Other Courses

Course Code	Course Title	Credit hours
	Floriculture & Landscaping	
FLS 501	Commercial Production of Cut Flowers	2+1
FLS 502	Commercial Production of Loose Flowers	2+1
FLS 503	Ornamental Gardening and Landscaping	2+1
	Plantation, Spices, Medicinal and Aromatic Crops	
PSM 501	Production of Plantation Crops	2+1
PSM 502	Production of Spice Crops	2+1
PSM 503	Production of Medicinal and Aromatic Crops	2+1
	Postharvest management	
PHM 501	Postharvest Management of Horticultural Produce	2+1
PHM 502	Packaging and Storage of Fresh Horticultural Produce	1+1
PHM 503	Processing of Horticultural Produce	2+2

Syllabi for courses on Fruit Science

FSC 501: Tropical Fruit Production (2+1)

Aim of the course: To impart comprehensive knowledge to the students on cultural and management practices for growing tropical fruits.

Theory:
Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.
Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.
Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.
Unit I: Mango
Unit II: Banana, Guava
Unit III: Papaya, Pineapple, Sapota
Unit IV: Avocado, Jackfruit
Unit V: Annonas, Aonla, Ber. etc.

Practicals:
• Distinguished features of tropical fruit species, cultivars and rootstocks
• Demonstration of planting systems, training and pruning
• Hands on practices on pollination and crop regulation
• Leaf sampling and nutrient analysis
• Physiological disorders-malady diagnosis
• Physico-chemical analysis of fruit quality attributes
• Field/ Exposure visits to tropical orchards
• Project preparation for establishing commercial orchards

Learning outcome: The students are expected to equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production of tropical fruits, which helps them to develop entrepreneurship with self-employability.

FSC 502: Sub-Tropical and Temperate Fruit Production (2+1)

Aim of the course: To impart comprehensive knowledge to the students on cultural and management practices for growing subtropical and temperate fruits.

Theory:
Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

Propagation, Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.
Unit I: Citrus, Grapes
Unit II: Litchi, Pomegranate
Unit III: Apple, Pear, Peach, Plum, Apricot
Unit IV: Cherries, Berries, Persimmon, Kiwifruit
Unit V: Nuts- Walnut, Almond, Pecan, etc.

Practicals:
• Distinguished features of fruit species, cultivars and rootstocks
• Demonstration of planting systems, training and pruning
• Hands on practices on pollination and crop regulation
• Leaf sampling and nutrient analysis
• Physiological disorders-malady diagnosis
• Physico-chemical analysis of fruit quality attributes
• Field/ Exposure visits to subtropical and temperate orchards
• Project preparation for establishing commercial orchards

Learning outcome: After successful completion of the course, the students are expected to equip themselves with principles and practices of producing subtropical and temperate fruits and nuts. This course has scope to entrepreneurship development and employment generation.

FSC 503: Propagation and Nursery Management of Fruit Crops (2+1)

Aim of the course: To understand the principles and methods of propagation and nursery management in fruit crops.

Theory:
Unit I: General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

Unit II: Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.
Unit III: Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship – graft incompatibility, physiology of rootstock and top working.
Unit IV: Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.
Unit V: Nursery management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

Practicals:
• Hands on practices on rooting of dormant and summer cuttings
• Anatomical studies in rooting of cutting and graft union
• Propagation by layering and stooling
• Hands on practices on various methods of budding
• Hands on practices on various methods of grafting
• Visit to commercial nurseries
• Visit to commercial tissue culture laboratories

Learning outcome: The student would be expected to equip to acquire skills and knowledge on principles and practices of macro- and micro-propagation and the handling of propagated material in nursery. This course can built commercial base for venturing commercial nursery as entrepreneurship and having good scope of employability.

FSC 504: Breeding of Fruit Crops (2+1)
Aim of the course: To impart comprehensive knowledge on principles and practices of fruit breeding.

Theory:
Importance, Taxonomy and Genetic Resources: Introduction and importance, origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources.

Blossom Biology and Breeding Systems: Blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes.

Conventional and Non-Conventional Breeding: Approaches for crop improvement – direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts.

Unit I: Mango, Banana,
Unit II: Guava, Papaya, Citrus, Grapes
Unit III: Pineapple, Litchi, Pomegranate
Unit IV: Apple, Pear, Plum, Peach, Apricot
Unit V: Cherries, Strawberry, Kiwifruit, Nuts

Practicals:
• Exercises on bearing habit, floral biology
• Pollen viability and fertility studies
• Hands on practices in hybridization
• Raising and handling of hybrid progenies
• Induction of mutations and polyploidy
• Evaluation of biometrical traits and quality traits
• Screening for resistance against abiotic stresses
• Developing breeding programme for specific traits
• Visit to research stations working on fruit breeding

Learning outcome: After successful completion of the course, the students are expected to have an understanding on importance and peculiarities of fruit breeding, have an updated knowledge on reproductive biology, genetics and inherent breeding systems and have detailed knowledge of various methods/ approaches of breeding fruit crops.

FSC 505: Systematics of Fruit Crops (2+1)

Aim of the course: To acquaint with the classification, nomenclature and description of various fruit crops.

Theory:
Unit I: Biosystematics – introduction and significance; history of nomenclature of cultivated plants, classification and nomenclature systems; International code of nomenclature for cultivated plants.
Unit II: Identification and Description: Methods of identification and description of cultivated fruit and nut species and their wild relatives features; development of plant keys for systematic identification and classification.
Unit III: Development of fruit crop descriptors- based upon Bioversity International Descriptors and UPOV/ DUS test guidelines
Unit IV: Botanical and pomological description of major cultivars and rootstocks of tropical, subtropical and temperate fruits and nut crops
Unit V: Registration and Modern Systematics: Registration, Use of chemotaxonomy, biochemical and molecular markers in modern systematic

Practicals:
• Exercises on identification and pomological description of various fruit species and cultivars

• Development of descriptive blanks vis-a-vis UPOV/ DUS test guidelines and Bioversity International
• Descriptors for developing fruit species and cultivar descriptive databases
• Visits to major germplasm centres and field genebanks

Learning outcome: After successful completion of the course, the students would be able to categories different fruit species into broad groups, to identify various fruit cultivars on basis of distinguishing features and to characterize fruit cultivars for description, registration and protection.

FSC 506: Canopy Management in Fruit Crops (1+1)

Aim of the course: To impart knowledge on principles and practices in management of canopy architecture for quality fruit production.

Theory:
Unit I: Introduction, Types and Classification: Canopy management – importance and factors affecting canopy development. Canopy types and structures,
Unit II: Canopy manipulation for optimum utilization of light and its interception. Spacing and utilization of land area – Canopy classification.
Unit III: Physical Manipulation and Growth Regulation: Canopy management through rootstock and scion. Canopy management through plant growth regulators, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality
Unit IV: Canopy management in mango, guava, citrus, litchi, pomegranate, grapes, avocado, ber, aonla etc.
Unit V: Canopy management in apple, peach, pear, plum, cherry, kiwi, nuts etc.

Practicals:
• Study of different types of canopies
• Training of plants for different canopy types
• Canopy development through pruning
• Understanding bearing behaviour and canopy management in different fruits
• Use of plant growth regulators
• Geometry of planting
• Development of effective canopy with support system
• Study on effect of different canopy types on production and quality of fruits

Learning outcome: After successful completion of the course, the students are expected to learn the basic principles of canopy management to modify plant architecture, to develop the skills on training and pruning of fruit crops, and growth regulation.

FSC 507: Growth and Development of Fruit Crops (2+1)

Aim of the course: To develop comprehensive understanding on growth and development of fruit crops.

Theory:
Unit I: General Concepts and Principles: Growth and development- definition, parameters of growth and development, growth dynamics and morphogenesis.
Unit II: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and thermoperiodism.
Unit III: Assimilate partitioning, influence of water and mineral nutrition in growth and development; concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brasssinosteroids, other New PGRs.
Unit IV: Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.
Unit V: Strategies for Overcoming Stress: Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations and Commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development.

Practicals:
• Understanding dormancy mechanisms in fruit crops and seed stratification
• Techniques of growth analysis
• Evaluation of photosynthetic efficiency under different environments
• Exercises on hormone assays
• Practicals on use of growth regulators
• Understanding ripening phenomenon in fruits
• Study on impact of physical manipulations on growth and development
• Study on chemical manipulations on growth and development
• Understanding stress impact on growth and development

Learning outcome: Consequent upon successful completion of the course, the students are expected to have equipped with understanding of various growth and development processes, learned about the role of environment and growth substances, acquired the skills to realise optimum growth and development under stress conditions

FSC 508: Nutrition of Fruit Crops (2+1)

Aim of the course: To acquaint with principles and practices involved in nutrition of fruit crops.

Theory:
Unit I: General Concepts and Principles: Importance and history of nutrition in fruit crops, essential plant nutrients, factors affecting plant nutrition; nutrient uptake and their removal from soil.

Unit II: Diagnostics, Estimation and Application: Nutrient requirements, root distribution in fruit crops, soil and foliar application of nutrients in major fruit crops, fertilizer use efficiency.
Unit III: Methods and techniques for evaluating the requirement of macro- and micro-elements, Diagnostic and interpretation techniques including DRIS.
Unit IV: Role of different macroand micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders.
Unit V: Integrated Nutrient Management (INM): Fertigation in fruit crops, biofertilizers and their use in INM systems.

Practicals:
• Visual identification of nutrient deficiency symptoms in fruit crops
• Identification and application of organic, inorganic and bio-fertilizers
• Soil/ tissue collection and preparation for macro- and micro-nutrient analysis
• Analysis of soil physical and chemical properties- pH, EC, Organic carbon
• Determination of N,P,K and other macro- and micronutrients
• Fertigation in glasshouse and field grown horticultural crops
• Preparation of micro-nutrient solutions, their spray and soil applications

Learning outcome: After successful completion of the course, the students would be expected to know the importance and various types of nutrients and their uptake mechanisms, analyse soil and plant status with respect to various nutrients and make use of corrective measures to overcome deficiency or toxicity.

FSC 509: Biotechnology of Fruit Crops (2+1)

Aim of the course: To impart knowledge on the principles and tools of biotechnology.

Theory:
Unit I: Introduction, History and Basic Principles: Introduction and significance, history and basic principles, influence of explant material, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.
Unit II: In-vitro Culture and Hardening: Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture.
Unit III; Use of bioreactors and in-vitro methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues. Hardening and ex vitro establishment of tissue cultured plants.
Unit IV: *In-vitro* Breeding, Transgenics and Gene Technologies: Somatic cell hybridisation, construction and identification of somatic hybrids and cybrids, wide hybridization, in-vitro pollination and fertilization, haploids, in-vitro mutation, artificial seeds, cryopreservation, In-vitro selection for biotic and abiotic stress.
Unit V: Genetic engineering- principles and methods, transgenics in fruit crops, use of molecular markers and genomics. Gene silencing, gene tagging, gene editing, achievements of biotechnology in fruit crops.

Prcaticals:
• An exposure to low cost, commercial and homestead tissue culture laboratories
• Media preparation, Inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus
• Sub-culturing techniques on anther, ovule, embryo culture, somaclonal variation
• *In-vitro* mutant selection against abiotic stress
• Protoplast culture and fusion technique
• Development of protocols for mass multiplication
• Project development for establishment of commercial tissue culture laboratory

Learning outcome: After the successful completion of the course, the students are expected to know the basic principles and methods of plant tissue culture and other biotechnological tools and the use and progress of biotechnology in fruit crops.

FSC 510: Organic Fruit Culture (2+1)

Aim of the course: To develop understanding on organic production of fruit crops.

Theory:
Unit I: Principles and Current Scenario: Organic horticulture, scope, area, production and world trade, definition, principles, methods and SWOT analysis.
Unit II: Farming System and Practices: Organic farming systems including biodynamic farming, natural farming, homa organic farming, rishi krishi, EM technology, cosmic farming;
Unit III: on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes, inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management. Organic seeds and planting materials, soil health management in organic production
Unit IV: Weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops.
Unit V: Inspection, Control Measures and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification), transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of custody, certification trademark – The Logo, accredited certification bodies under NPOP. Constraints in certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production.

Practicals:
•Design of organic orchards/ farms management
• Conversion plan
• Nutrient management and microbial assessment of composts and bio-enhancers
• Preparation and application of composts, bio-enhancers and bio-pesticides
• Organic nursery raising

• Application of composts, bio-enhancers, bio-fertilisers and bio-pesticides, green manure, cover, mulching
• Preparation and use of neem based products
• Biodynamic preparations and their role in organic agriculture, EM technology and products, biological/ natural management of pests and diseases
• Soil solarisation

Learning outcome: On successful completion of the course, the students are expected to be able to familiarize with the concepts and practices of organic and other natural farming systems and to generate know-how on procedures, policies and regulation for inspection and certification of organic produce. This course offers entrepreneurship development and has the scope of employability.

FSC 511: Export Oriented Fruit Production (2+1)

Aim of the course: To acquaints with the national and international standards and export potential of fruit crops.

Theory:
Unit I: Statistics and World Trade: National and international fruit export and import scenario and trends; Statistics and India's position and potentiality in world trade; export promotion zones in India. Government Policies.
Unit II: Policies, Norms and Standards: Scope, produce specifications, quality and safety standards for export of fruits, viz., mango, banana, grape, litchi, pomegranate, walnut, apple and other important fruits.
Unit III: Processed and value-added products, post harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; WTO and its implications, sanitary and phyto-sanitary measures.
Unit IV: Infrastructure and Plant Material: Quality fruit production under protected environment; different types of structures – Automated greenhouses, glasshouse, shade net, poly tunnels – Design and development of low cost greenhouse structures.
Unit V: Seed and planting material; meeting export standards, implications of plant variety protection – patent regimes.

Practicals:
• Export promotion zones and export scenario of fresh fruits and their products
• Practical exercises on quality standards of fruits for export purpose
• Quality standards of planting material and seeds
• Hi-tech nursery in fruits
• Practicals on ISO specifications and HACCP for export of fruits
• Sanitary and phyto-sanitary measures during export of horticultural produce
• Post harvest management chain of horticultural produce for exports
• Visit to export oriented units/ agencies like APEDA, NHB, etc.

Learning outcome: Consequent upon successful completion of the course, the students are expected to have learnt about the National and international trade scenario of fruit crops. The can learn on set norms and standards for export of fruit crops and requisite infrastructure and growing practices meeting export standards. This course offers the entrepreneurship development on export oriented fruit production and has the scope of employability.

FSC 512: Climate Change and Fruit Crops (1+0)

Aim of the course: To understand the impact of climate change and its management in fruit production.

Theory:
Unit I: Introduction, Global Warming and Climatic Variability: Introduction to climate change. Factors directly affecting climate change. Global warming, effect of climate change on spatio-temporal patterns of temperature and rainfall, concentrations of greenhouse gasses in atmosphere. pollution levels such as tropospheric ozone, change in climatic variability and extreme events.
Unit II: Impact Assessment and Mitigation: Sensors for recording climatic parameters, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, longer growing seasons and shifts in plant hardiness for fruit crops.
Unit III: Climate mitigation measures through crop management- use of tolerant rootstocks and varieties, mulching – use of plastic- windbreak- spectral changes- protection from frost and heat waves. Climate management in greenhouse- heating – vents – CO2 injection – screens – artificial light.
Unit IV: Impact of climate changes on invasive insect, disease, weed, fruit yield, quality and sustainability. Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems.
Unit V: Response to Climate Change: Case studies – responses of fruit trees to climatic variability vis-a-vis tolerance and adaptation; role of fruit tree in carbon sequestration.

Learning outcome: After the successful completion of the course, the students are expected to have learnt the nature and extent of altered behaviour or damage due to climate change, methods to assess the adverse effects, and approaches to mitigate the effect due to climatic variability.

FSC 514: Minor Fruit Production (2+1)

Aim of the course: To import basic knowledge underexploited minor fruit crops.

Theory:
Occurrence, Adoption and General Account: Importance – occurrence and distribution, climate adaptation in fragile ecosystem and wastelands.
Propagation and Cultural Practices: Traditional cultural practices and recent development in agro-techniques; propagation, botany-floral biology, growth patterns, mode of pollination, fruit set, ripening, fruit quality.

Post-Harvest Management: Post harvest management, marketing; minor fruit crops in terms of medicinal and antioxidant values; their uses for edible purpose and in processing industry

Unit I: Bael, fig, passion fruit,
Unit II: Jamun, phalsa, karonda, woodapple,
Unit III: Loquat, tamarind, dragon fruit, monkey jack,
Unit IV: Persimmon, pistachio, Rose apple, water apple, carambolla
Unit V: Amra, kokum, cape gooseberry, kaphal and other minor fruits of regional importance.

Practicals:
• Visits to institutes located in the hot and cold arid regions of the country
• Identification of minor fruits plants/ cultivars
• Collection of leaves and preparation of herbarium
• Allelopathic studies
• Generating know-how on reproductive biology of minor fruits
• Fruit quality attributes and biochemical analysis
• Project formulation for establishing commercial orchards in fragile ecosystems

Learning outcome: The students are expected to know the basics of minor fruits and agro-techniques for establishment and management of minor fruit orchard leading to productivity and quality enhancement of fruits. By completing this course students may establish minor fruit orchand and related processing unit for value addition, which helps them to develop entrepreneurship with self-employability.

Syllabi for courses on Vegetable Science

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

Aim of the course: To impart knowledge and skills on advancement in production technology of cool season vegetable.

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, sowing/ planting time and methods, hrydroponics 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.

Practicals:
• Scientific raising of nursery and seed treatment
• Sowing and transplanting
• 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 cool 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

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of cool season vegetable crops in India, acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops and calculate the economics of vegetable production in India. This course offers good scope of entrepreneurship development in cool season vegetable production and employability.

VSC 502: Production of Warm Season Vegetable Crops (2+1)

Aim of the course: To impart knowledge and skills on advancement in production technology of warm season vegetable crops.

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.

Practicals:
• 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.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of warml season vegetable crops in India, acquire knowledge about the production technology and post-harvest handling of warm season vegetable crops and calculate the economics of vegetable production in India. This course offers good scope of entrepreneurship development in warm season vegetable production and employability.

VSC 503: Growth and Development of Vegetable Crops (2+1)

Aim of the course: To teach the physiology of growth and development of vegetable crops.

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, gibberellilns, cyktokinins and abscissic 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.

Practicals:
• 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.

Learning outcome: After successful completion of this course, the students are expected to acquire knowledge about the growth and development of plants in vegetable crops, distinguish between primary and secondary growth in plant stems and understand how hormones affect the growth and development of vegetable crops.

VSC 504: Principles of Vegetable Breeding (2+1)

Aim of the course: To teach basic principles and practices of vegetable breeding.

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.

Practicals:
• 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 approaches

Learning outcome: After successful completion of this course, the students are expected to acquire knowledge about the principles of vegetable breeding, improve yield, quality, abiotic and biotic resistance, other important traits of vegetable crops and understand how the basic principles are important to start breeding of vegetable crops.

VSC 505: Breeding of Self pollinated Vegetable Crops (2+1)

Aim of the course: To impart comprehensive knowledge about principles and practices of breeding of self pollinated vegetable crops.

Theory:
Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act.
Unit I: Tuber crops: Potato.
Unit II: Fruit vegetables- Tomato, eggplant, hot pepper, sweet pepper and okra.
Unit III: Leguminous vegetables- Garden peas and cowpea.
Unit IV: Leguminous vegetables: French bean, Indian bean, cluster bean and broad bean.
Unit V: Leafy vegetables- Lettuce and fenugreek.

Practicals:
• Floral mechanisms favouring self and often cross pollination
• Progeny testing and development of inbred lines
• Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations
• Palynological studies, selfing and crossing techniques
• Hybrid seed production of vegetable crops in bulk
• Screening techniques for biotic and abiotic stress resistance in above mentioned crops
• Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques
• Visit to breeding farms

Learning outcome: After successful completion of this course, the students are expected to acquire knowledge about the breeding of self pollinated vegetable crops, improve yield, quality, abiotic and biotic resistance and other important traits of vegetable crops and understand how to start the breeding of self pollinated vegetable crops.

VSC 506: Breeding of Cross Pollinated Vegetable Crops (2+1)

Aim of the course: To impart comprehensive knowledge about principles and practices of cross pollinated vegetable crops breeding.

Theory:
Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act

Unit I: Cucurbitaceous crops—Gourds, melons, cucumber, pumpkin and squashes.
Unit II: Cole crops—Cauliflower, cabbage, kohlrabi, broccoli and brussels sprouts.
Unit III: Root and bulb crops—Carrot, radish, turnip, beet root and onion.
Unit IV: Tuber crops—Sweet potato, tapioca, taro and yam.
Unit V: Leafy vegetables—Beet leaf, spinach, amaranth and coriander.

Practicals
• Floral mechanisms favouring cross pollination
• Development of inbred lines
• Selection of desirable plants from breeding population
• Observations and analysis of various quantitative and qualitative traits in germplasm, hybrids and segregating generations
• Induction of flowering, palynological studies, selfing and crossing techniques
• Hybrid seed production of vegetable crops in bulk; Screening techniques for biotic and abiotic stress resistance in above mentioned crops
• Demonstration of sib-mating and mixed population
• Molecular marker techniques to identify useful traits in vegetable crops and special breeding techniques
• Visit to breeding blocks.

Learning outcome: After successful completion of this course, the students are expected to acquire knowledge about the breeding of cross pollinated vegetable crops, improve yield, quality, abiotic and biotic resistance, and important traits of cross pollinated vegetable crops and understand how to start the breeding of cross pollinated vegetable crops.

VSC 507: Protected Cultivation of Vegetable Crops (1+1)

Aim of the course: To impart latest knowledge about growing of vegetable crops under protected environmental conditions.

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.

Practicals:
• 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.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of protected cultivation of vegetable crops in India, acquire knowledge about the effect of abiotic factors on growth, flowering and production of vegetable crops, gaining knowledge about the designing of various low cost protected structures and adopting the raising of vegetable seedlings in low cost protected structures as entrepreneur, which generate employability.

VSC 508: Seed Production of Vegetable Crops (2+1)

Aim of the course: To impart a comprehensive knowledge and skills on quality seed production of vegetable crops.

Theory:
Unit I: Introduction, history, propagation and reproduction—Introduction, definition of seed and its quality, seed morphology, development and maturation; Apomixis and fertilization; Modes of propagation and reproductive behaviour; Pollination mechanisms and sex forms in vegetables; History of vegetable seed production; Status and share of vegetable seeds in seed industry
Unit II: Agro-climate and methods of seed production—Agro-climate and its influence on quality seed production; Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production; Methods of seed production, hybrid seeds and techniques of large scale hybrid seed production; Seed village concept
Unit III: Seed multiplication and its quality maintenance—Seed multiplication ratios and replacement rates in vegetables; Generation system of seed multiplication; Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds; Seed quality and mechanisms of genetic purity testing
Unit IV: Seed harvesting, extraction and its processing—Maturity standards; Seed harvesting, curing and extraction; Seed processing, viz., cleaning, drying and treatment of seeds, seed health

and quality enhancement, packaging and marketing; Principles of seed storage; Orthodox and recalcitrant seeds; Seed dormancy

Unit V: Improved agro-techniques and field and seed standards—Improved agro-techniques; Field and seed standards in important solanaceous, leguminous and cucurbitaceous vegetables, cole crops, leafy vegetables, bulbous and root crops and okra; clonal propagation and multiplication in vegetative propagated crops; Seed plot technique and true potato seed production in potato

Practicals:

- Study of floral biology and pollination mechanisms in vegetables
- Determination of modes of pollination
- Field and seed standards
- Use of pollination control mechanisms in hybrid seed production of important vegetables
- Maturity standards and seed extraction methods
- Seed sampling and testing
- Visit to commercial seed production areas
- Visit to seed processing plant
- Visit to seed testing laboratories.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of seed production of vegetable crops in India, acquire knowledge about the complete seed production technology, extraction and post-extraction processing of vegetable seeds and adoption of seed production of vegetable crops as entrepreneur, which generate employability.

VSC 509: Production of Underutilized Vegetable Crops (2+1)

Aim of the course: To impart knowledge about production technology of lesser utilized vegetable crops.

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

Practicals:

- 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.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of production of underutilized vegetable crops in India, acquire knowledge about the production technology of underutilized vegetable crops and adopting production of lesser-utilised crops as entrepreneur, which may generate employability.

VSC 510: Systematics of Vegetable Crops (1+1)

Aim of the course: To impart knowledge on morphological, cytological and molecular taxonomy of vegetable crops.

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

Practicals:
• 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.

Learning outcome: After successful completion of this course, the students are expected to acquire knowledge on identification, description, classification and maintenance of vegetable species and varieties, collecting locally available allied species of vegetable crops and preparing herbarium and specimens.

VSC 511: Organic Vegetable Production (1+1)

Aim of the course: To elucidate principles, concepts and their applications in organic farming of vegetable crops.

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, Panchyagavvya, 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 GMPcertification of organic products; Export- opportunity and challenges

Practicals:
• 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.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of organic vegetable production in India, acquire knowledge about the organic vegetable production technology and adopting production of organic vegetable crops a s entrepreneur, which generate employability.

VSC 512: Production of Spice Crops (2+1)

Aim of the course: To impart basic knowledge about the importance and production technology of spices grown in India.

Theory:
Introduction and importance of spice crops- historical accent, present status (national and international), future prospects, botany and taxonomy, climatic and soil requirement, commercial cultivars/ hybrids, site selection, layout, sowing/ planting time and methods, seed rate and seed treatment, nutritional and irrigation requirement, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures, quality control and pharmaceutical significance of crops mentioned below:
Unit I: Fruit spices- Black pepper, small cardamom, large cardamom and allspice
Unit II: Bud and kernel- Clove and nutmeg
Unit III: Underground spices- Turmeric, ginger and garlic
Unit IV: Seed spices- Coriander, fenugreek, cumin, fennel, ajowain, dill and celery

Unit V: Tree spices- Cinnamon, tamarind, garcinia and vanilla

Practicals
• Identification of seeds and plants
• Botanical description of plant
• Preparation of spice herbarium
• Propagation
• Nursery raising
• Field layout and method of planting
• Cultural practices
• Harvesting, drying, storage, packaging and processing
• Value addition
• Short term experiments on spice crops.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of production of spice crops in India, acquire knowledge about the production technology and processing of spice crops and adopting production of spice crops as entrepreneur, which generate employability.

VSC 513: Processing of Vegetable Crops (1+1)

Aim of the course: To educate the students about the principles and practices of processing in vegetable crops.

Theory:
Unit I: Present status—Present status and future prospects of vegetable preservation industry in India
Unit II: Spoilage and biochemical changes—Spoilage of fresh and processed vegetable produce; biochemical changes and enzymes associated with spoilage of vegetable produce; Principal spoilage organisms, food poisoning and their control measures; Role of microorganisms in food preservation
Unit III: Processing equipments—Raw material for processing; Primary and minimal processing; Processing equipments; Layout and establishment of processing industry; FPO licence; Importance of hygiene; Plant sanitation
Unit IV: Quality control—Quality assurance and quality control, TQM, GMP; Food standardsFPO, PFA, etc.; Food laws and regulations; Food safety- hazard analysis and critical control points (HACCP); Labeling and labeling act and nutrition labeling
Unit V: Value addition—Major value added vegetable products; Utilization of byproducts of vegetable processing industry; Management of processing industry waste; Investment analysis; Principles and methods of sensory evaluation of fresh and processed vegetables

Practicals
• Study of machinery and equipments used in processing of vegetable produce
• Chemical analysis for nutritive value of fresh and processed vegetable
• Study of different types of spoilage in fresh as well as processed vegetable 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, hygiene, sanitation and waste management.

Learning outcome: After successful completion of this course, the students are expected to appreciate the scope and scenario of vegetable processing in India, acquire knowledge about the processing technology of vegetable crops, adopting processing products of vegetable crops at small or medium scale and adopt processing of vegetable crops as entrepreneur, which generate employability.

VSC 514: Postharvest management of Vegetables (2+1)

Aim of the course: To facilitate deeper understanding of principles and to acquaint the student with proper handling and management technologies of vegetable crops for minimizing the post-harvest losses.

Theory:
Unit I: Importance and scope—Importance and scope of post-harvest management of vegetables
Unit II: Maturity indices and biochemistry—Maturity indices and standards for different vegetables; Methods of maturity determination; Biochemistry of maturity and ripening; Enzymatic and textural changes; Ethylene evolution and ethylene management; Respiration and transpiration along with their regulation methods
Unit III: Harvesting and losses factors—Harvesting tools and practices for specific market requirement; Postharvest physical and biochemical changes; Preharvest practices and other factors affecting postharvest losses
Unit IV: Packing house operations—Packing house operations; Commodity pretreatments chemicals, wax coating, precooling and irradiation; Packaging of vegetables, prevention from infestation, management of postharvest diseases and principles of transportation
Unit V: Methods of storage—Ventilated, refrigerated, modified atmosphere and controlled atmosphere storage, hypobaric storage and cold storage; Zero-energy cool chamber, storage disorders like chilling injury in vegetables

Practicals
• Studies on stages and maturing indices
• Ripening of commercially important vegetable crops
• Studies of harvesting, pre-cooling, pre-treatments, physiological disorders- chilling injury
• Improved packaging
• Use of chemicals for ripening and enhancing shelf life of vegetables
• Physiological loss in weight, estimation of transpiration, respiration rate and ethylene release
• Storage of important vegetables
• Cold chain management
• Visit to commercial packinghouse, cold storage and control atmosphere storage.

Learning outcome: After successful completion of this course, the students are expected to be able to understand the regulation of postharvest losses by using chemicals and growth regulators, pre and postharvest treatments for extending shelf life of vegetable crops, packing house operations for extending the shelf life of vegetable crops and successful storage of vegetable crops. Scope of entrepreneurship development and employment generation with commercial pack house management.

Syllabi for other courses

Floriculture & Landscaping

FLS 501: Commercial Production of Cut Flowers (2+1)

Aim of the course: To impart basic knowledge about the importance and production dynamics of cut flowers grown in India.

Theory
Scope and scenario: National and International scenario, importance and scope of cut flower trade, constraints for cut flower production in India. Growing environment: Soli analysis, soil health card, Growing environment, open cultivation, protected cultivation, soil/ media requirements, land preparation, planting methods, influence of light, temperature, moisture, humidity and microclimate management on growth and flowering. Crop management: Commercial Flower production – Commercial varieties, water and nutrient management, fertigation, weed management, crop specific practices, ratooning, training and pruning, pinching, deshooting, bending, desuckering, disbudding. Use of growth regulators, physiological disorders and remedies, IPM and IDM. Flower regulation: Flower forcing and year round/ offseason flower production through physiological interventions, chemical regulation, environmental manipulation. Post-harvest management and marketing: Post harvest management: Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, storage and transportation. Marketing: Marketing, export potential, institutional support, Agri Export Zones, 100% Export Oriented units, Crop Insurance.
Unit I: Rose, chrysanthemum, gladiolus, tuberose,
Unit II: Carnation, gerbera, orchids, lilium, anthurium,
Unit III: China aster, alstroemeria, bird of paradise, heliconia, alpinia,
Unit IV: Ornamental ginger, dahlia, gypsophila, solidago, limonium, stock,
Unit V: cut greens and fillers.

Practicals:
• Identification of varieties
• Propagation
• Microclimate management
• Training and pruning techniques
• Pinching, deshooting, disbudding, desuckering

• Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application
• Harvesting techniques, post-harvest handling, cold chain
• Economics, Project preparation for regionally important cut flowers, crop specific guidelines for project financing (NHB guidelines)
• Visit to commercial cut flower units

Learning outcome: After successful completion of this course, the students are expected to understand the scope and scenario of floriculture, a thorough understanding of production and post harvest management of flower crops and acquire the required skills to prepare project reports on different crops for financing. This course has scope of entrepreneurship development and employment generation.

FLS 502: Commercial Production of Loose Flowers (2+1)

Aim of the course: To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory:
Scope and scenario: Scope, scenario and importance of loose flowers, constraints and opportunities in loose flower production. Growing environment: Nursery management, pro-tray nursery under shade nets, soil and climate requirement, Field preparation, systems of planting. Crop management: Soli analysis, soil health card, water and nutrient management, weed management, training and pruning, special horticultural practices such as pinching and disbudding, use of growth regulators, physiological disorders and remedies, INM, IPM and IDM. Crop regulation: Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation. Post harvest management and marketing Post harvest management: Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packaging and storage. Marketing: Important local markets, Export potential, transportation and marketing, APMC and online trading, institutional support, Crop Insurance.

Unit I: Rose, jasmine, chrysanthemum, marigold, tuberose,
Unit II: China aster, crossandra, gaillardia, spider lily
Unit III: Hibiscus, nerium, barleria, celosia, gomphrena,
Unit IV: Madar (Calotropis gigantea), nyctanthes (Harsingar), tabernaemontana (Chandni),
Unit V: Lotus, water lily, michelia (Champa), gardenia, ixora and balsam.

Practicals:
• Identification of species and varieties
• Propagation and nursery management
• Training and pruning techniques
• Fertigation, foliar nutrition, growth regulator application
• Crop protection
• Pinching, disbudding, staking, harvesting techniques
• Post-harvest handling, storage and cold chain

• Project preparation for regionally important commercial loose flowers. crop specific guidelines for project financing (NHB guidelines)
• Cost Economics
• Exposure Visits to fields

Learning outcome: After successful completion of this course, the students would have a thorough understanding of production and post harvest management of loose flowers and they develop the required skills on commercial production management. This course has scope of entrepreneurship development and employment generation.

FLS 503: Ornamental Gardening and Landscaping (2+1)

Aim of the course: Familiarization with principles and practices of landscaping.

Theory:
Unit I: Styles and types of gardens: Historical background of gardening, Importance and scope of ornamental gardening, styles and types of gardens, formal and informal style gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu and Buddhist gardens.
Unit II: Garden components: Garden components (living and non-living): arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, colour wheels, clock garden, bamboo groves, bonsai; Non -living components likepath, garden gate, fencing, paving and garden features like fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls, bridge, steps, ramps, Lawn -genera and species, establishment and maintenance.
Unit III: Specialized gardens: Specialised gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens (with emphasis on native plants), Zen garden. Block 2: Landscape planning
Unit IV: Principles and elements of landscaping: Basic drawing skills, use of drawing instruments garden symbols, steps in preparation of garden design, programmes phase, design, phase, etc. Elements and principles of landscape design. Organization of spaces, visual aspects of plan arrangement- view, vista and axis. Principles of circulation, site analysis and landscape, water requirement, use of recycled water.
Unit V: Landscaping for different situations: Urban landscaping, Landscaping for specific situations such as residential, farm houses, institutions, corporate sector, industries, hospitals, roadsides, traffic islands, Children parks, public parks, xeriscaping, airports, railway station and tracks, river banks and dam sites and IT/ SEZ parks. Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening.

Practicals:
• Graphic language and symbols in landscaping, study of drawing instruments, viz., 'T' square, setsquare, drawing board, etc.
• Identification of various types of ornamental plants for different gardens and occasions
• Preparation of land, planning, layout and planting, deviations from landscape principles
• Site analysis, interpretation of map of different sites, use of GIS for selection

• Enlargement from blue print. Landscape design layout and drafting on paper as per the scale
• Preparation of garden models for home gardens, farm houses, industrial gardens, institutional gardens, corporate, avenue planting, practices in planning and planting of special types of gardens
• Lawn making, planting of edges, hedges, topiary, herbaceous and shrubbery
• Project preparation on landscaping for different situations, creation of formal and informal gardens
• Visit to parks and botanical gardens

Learning outcome: After successful completion of this course, the students are expected to be apprised of different types of gardens and have a thorough understanding of principles of landscape gardening and they develop skills for landscaping under different situations and layout of garden components. This course has scope of entrepreneurship development and employment generation.

Plantation, Spices, Medicinal and Aromatic Crops

PSM 501: Production of Plantation Crops (2+1)

Aim of the course: The course is designed to provide both basic and applied knowledge on various aspects of production technology of plantation crops grown in India.

Theory:
Role of plantation crops: Role of plantation crops in national economy, area-production statistics at national and international level, classification, clean development mechanism and carbon sequestration potential of plantation crops. Export potential: Export potential, problems and prospects and IPR issues in plantation crops. Promotional programmes: Role of commodity boards and directorates in the development programmes of plantation crops. Varietal wealth: Botany, taxonomy, species, cultivars and improved varieties in plantation crops. Propagation and nursery management: Plant multiplication including in-vitro multiplication, nursery techniques and nursery management in plantation crops. Agro techniques: Systems of cultivation, cropping systems, multitier cropping, climate and soil requirements, systems of planting, high density planting, nutritional requirements, water requirements, fertigation, moisture conservation, role of growth regulators, macro and micro nutrients, nutrient deficiency symptoms, physiological disorders, shade regulation, weed management, training and pruning, crop regulation, plant protection, management of drought, precision farming. Harvest and Post harvest management Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons and mechanized harvesting in plantation crops. Post harvest management: Post harvest handling including primary processing, grading, packaging, storage and benefit cost analysis of plantation crops.

Unit I: Coconut, Arecanut,
Unit II: Oilpalm, Cashew
Unit III: Coffee, Tea
Unit IV: Cocoa, Rubber

Unit V: Palmyrah, Betel vine

Practicals:
• Description of botanical and varietal features
• Selection of mother palms and seedlings
• Nursery techniques
• Soil and water conservation measures
• Nutrient deficiency symptoms
• Manuring practices
• Pruning and training methods
• Maturity standards
• Harvesting
• Project preparation for establishing plantations
• GAP in plantation crops
• Exposure visits to commercial plantations, research institutes

Learning outcome: After successful completion of this course, the students are expected to develop the technical skill in commercial cultivation of plantation crops and be able to start plantation crop-based enterprises, which have scope of employability.

PSM 502: Production of Spice Crops (2+1)

Aim of the course: The course is designed to provide both basic and applied knowledge on various aspects of production technology of spice crops grown in India.

Theory
Role of Spice crops: Introduction, importance of spice crops, pharmaceutical significance, historical accent, present status – national and international, future prospects, role of Spices board and other development agencies. Classification of spice crops: Major spices, minor spices, seed spices, tree spices, herbal spices. Production Technology: Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in spice crops. Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices. Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection, precision farming, physiological disorders, protected cultivation. Harvest and Post harvest management, Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons, mechanized harvesting. Post harvest management: Post harvest management including primary processing, grading, packaging and storage, GMP in major spice crops.

Unit I: Black pepper, small and large Cardamom
Unit II: Turmeric, Ginger, Garlic
Unit III: Coriander, Fenugreek, Cumin, Fennel, Ajwain
Unit IV: Saffron, Vanilla, Nutmeg, Allspice

Unit V: Clove, Cinnamon, Tamarind, Garcinia

Practicals:
• Identification of seeds and plants
• Botanical description of plant
• Varietal features
• Planting material production
• Field layout and method of planting
• Cultural practices
• Harvest maturity, harvesting
• Drying, storage, packaging
• Primary processing
• GAP in spice crops
• GMP in spice crops
• Short term experiments on spice crops
• Exposure visits to spice farms, research institutes.

Learning outcome: After successful completion of this course, the students are expected to develop the technical skill in commercial cultivation of spice crops and be able to start spice-based enterprises, which have scope of employability.

PSM 503: Production of Medicinal and Aromatic Crops (2+1)

Aim of the course: To impart comprehensive knowledge on the production technology of important medicinal and aromatic crops.

Theory:
Classification of medicinal and aromatic crops: Importance of medicinal plants, Importance of aromatic plants, Role in national economy, utility sectors of medicinal and aromatic crops, classification of medicinal and aromatic crops, role of institutions, Medicinal Plant Board and NGO's in research and development of medicinal and aromatic crops. Medicinal and plant based industry: Indian system of medicine, traditional systems of medicine, tribal medicine, medicinal industry, source of medicinal plants, area, production, export and import of major crops, problems, prospects and challenges, IPR issues. Aromatic plant based industry: Essential oils, classification, physical and chemical properties and storage of essential oils. Indian perfumery industry,area, production, export and import status of major aromatic crops, history and advancements, problems, prospects and challenges, IPR issues. Production technology of medicinal and aromatic crops: Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in medicinal and aromatic crops. Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices. Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection. Harvest and Post harvest management: Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons in medicinal and aromatic crops. Post harvest

management: Post harvest management including primary processing, extraction, grading, packaging and storage, GMP in medicinal and aromatic crops.
Unit I: Senna, periwinkle, medicinal coleus, aswagandha,
Unit II: Glory lily, sarpagandha, Dioscorea sp., Aloe vera, Andrographis paniculata, Digitalis, medicinal solanum, isabgol,
Unit III: Opium poppy, safedmusli, Stevia rebaudiana, Mucuna pruriens, Piper longum, Plumbago zeylanica
Unit IV: Palmarosa, lemongrass, citronella, vetiver, mentha, patchouli,
Unit V: Sweet flag, jasmine, geranium, artemisia, lavender, Ocimum sp., eucalyptus, sandal

Practicals:
• Description of botanical and varietal features
• Nursery techniques
• Lay out and planting
• Manuring practices
• Maturity standards
• Harvesting
• Primary processing
• Extraction of oils
• Herbarium preparation
• Project preparation for establishing herbal gardens
• GAP in medicinal and aromatic crops
• GMP in medicinal and aromatic crops
• Exposure visits to institutes, herbal gardens and industries.

Learning outcome: After successful completion of this course, the students are expected to develop the technical skill in commercial cultivation of medicinal and aromatic crops and be able to start medicinal and aromatic crop-based enterprises, which have scope of employability.

Postharvest management

PHM 501: Postharvest Management of Horticultural Produce (2+1)

Aim of the course: To impart comprehensive knowledge on management of horticultural produce thus extending the post-harvest life of the produce by various treatments.

Theory:
Unit I: History, Importance and scope of Postharvest technology of horticultural produce. Nature and structure of horticultural produce. Pre and Postharvest losses and their causes.
Unit II: Climacteric and non-climacteric fruits. Regulation of ripening by use of chemicals and growth regulators. Control of sprouting, rooting and discoloration in vegetables.
Unit III: Maturity indices for harvest. Harvesting and harvesting tools. Curing in roots and tubers. Prepackage Operation: Preecooling, washing, sorting, grading of horticultural perishables for local markets and export. Postharvest handling of spices, plantation crops, medicinal and aromatic plants. Equipments for washing, sizing, grading.

Unit IV: Pre and Postharvest treatments for extending storage life/ vase life. VHT, irradiation treatment, skin coating, degreening, etc. Prepackaging, Packaging techniques for local market and export. Standardsand specifications for fresh produce.
Unit V: Postharvest handling system for horticulture crops of regional importance. Principles of transport, modes of transportation, types of vehicles and transit requirements for different horticultural produce. Marketing: Factors influencing marketing of perishable crops, marketing systems and organizations.

Practicals
• Study of maturity indices for harvest of fruits, vegetables, spices and plantation crops
• Protective skin coating with wax emulsion and pre and Postharvest treatment with fungicides, chemicals and growth regulators to extend the shelf life of fruits and vegetables
• Prepackaging of perishables
• Extension of vase life of cut flowers by use of chemicals and growth regulators
• Control of sprouting of potato and onion by using growth regulators
• Study of modern harvesting, sorting and grading equipments
• Study of effect of pre-cooling on shelf-life and quality of fresh fruits, vegetables and flowers
• Visit to packaging centers
• Visit to local markets, coop

Learning outcome: After successful completion of this course, the students are expected to be able to understand the regulation of ripening by use of chemicals and growth regulators, pre and Postharvest treatments for extending storage life/ vase life and standards and specifications for fresh produce. This course has commercial application and employability scope.

PHM 502: Packaging and Storage of Fresh Horticultural Produce (1+1)

Aim of the course: To acquaint with the different storage systems and packaging systems for perishable horticultural produce. The course is organized.

Theory:
Unit I: Importance of storage of horticultural produce, present status and future scope. Principles and methods of storage – field storage structures and designs for bulk storage of horticultural produce- onion and potato, etc. Evaporative cool chambers. Physiological changes during storage.
Unit II: Refrigerated storage – principles of refrigeration, types of refrigerants, refrigeration equipments. Cold storage rooms – Calculation of refrigeration load. Storage requirements of different fruits, vegetables, flowers. Storage disorder symptoms and control.
Unit III: Controlled or modified atmosphere (CA/MA) storage – principles, uses, structures and equipments, methods and requirements. Effect of CA storage on the physiology of stored produce. Hypobaric storage principle, uses, and requirements. Storage disorders.
Unit IV: Importance of packaging of fresh and processed horticultural produce, present status and future scope. Gaps in packaging concepts. Packaging requirements of fresh horticultural produce. Packaging patterns and methods. Food packaging systems: Different forms of packaging such as rigid, semi-rigid, flexible forms. Traditional, improved and specialized

packages. Paper based packages: corrugated fibre board boxes – raw material and types of boxes. Flexible packaging materials – types and their properties. Consumer and intermediate flexible bulk containers. Testing of flexible packaging material. Barrier properties of packaging materials.

Unit V: New technology in packaging – stretch wrapping system, vacuum packaging, gas packaging, controlled atmosphere (active and intelligent) packaging, vibra packaging, skin packaging, shrink packaging, formfill-seal packaging, Packaging machines.Quality control and safety aspects of packaging materials.

Practicals

• Study of special storage structures for bulk storage of onion/ potato, etc.
• Study of storage behavior of different fruits and vegetables in zero energy cool chamber
• Determination of refrigeration requirements (capacity) for given quantity of fruits and vegetables
• Study of storage behaviour of different fruits and vegetables in cold room; • Study of chilling injury and storage disorders
• Study of shelf-life of fruits and vegetables in modified atmosphere packaging.
• Visit to special storage structures, cold storage units. Study of types of packaging materials, types of plastic films and their properties
• Determination of water vapour transmission rate (WVTR) and gas transmission rate (GTR) of packaging material
• Applications of packaging material for fresh fruits and vegetables, beverages, spice products
• Determination of shelf-life of fresh products in different types of packages
• Study of packaging machines – vacuum packaging machine, shrink wrapping machine, double seamer, etc. Visit to packaging unit.

Learning outcome: After successful completion of this course, the students are expected to be able to understand the importance of storage of horticultural produce, different methods of storage, importance of packaging for fresh horticultural produce and different methods of packaging. This course has commercial utility and scope of employability.

PHM 503: Processing of Horticultural Produce (2+2)

Aim of the course: This course gives an overview of status of fruit and vegetable processing in the country, objectives and importance of preservation, important constraints and different unit operations processing industry which helps in expansion of industry and scope for further growth in this sector.

Theory:

Unit I: Processing unit- layout and establishment, processing tools. Quality requirements of raw materials for processing, preparation of raw material, primary processing: grading, sorting, cleaning, washing, peeling, slicing and blanching; minimal processing.

Unit II: Preparation of various processed products from fruits and vegetables, flowers; role of sugar and pectin in processed products. Jam, jelly, candy and tomato products, Freezing of fruits and vegetables. Containers, equipment and technologies in canning.

Unit III: Juice extractions, clarification and preservation, recent advances in juice processing technology, application of membrane technology in processing of juices, preparation of fruit beverages and juice concentrate. Sensory evaluation.
Unit IV: Processing equipment and enzyme kinetics: Dehydration of fruits and vegetables using various drying technologies and equipment, solar drying and dehydration, packaging technique for processed products.
Unit V: Quality assurance and storage system for processed products. Nutritive value of raw and processed products, plant sanitation and waste disposal. Types of horticultural and vegetables wastes and their uses, utilization of by- products from fruits and vegetables processing industries.

Practicals:
• Handling of harvesting equipments
• Determination of physical and thermal properties of horticultural commodities
• Primary processing methods
• Preparation of fruit juice beverages
• Drying and dehydration
• Preparation of jam, jelly etc.
• Preparation of tomato products
• Processing industries waste treatment
• Working of a canning unit
• Visit to commercial processing units and storage units.

Learning outcome: After successful completion of this course, the students are expected to be able to understand uUnit operations of processing, planning for domestic as well as commercial storage and processing facilities and kinetics of growth and enzyme reaction. This course has commercial utility and scope of employability.