

Detail Course Structures & Syllabus

For

**M.Sc.(Ag.) degree programme under
different disciplines of Horticulture**

- Fruit Science
- Vegetable Science
- Floriculture and Landscape Architecture
- Plantation, Spices, Medicinal & Aromatic Crops



**Department of Horticulture
SASRD, Medziphema Campus, NU
Medziphema – 797 106**

M.Sc.(Ag.) in HORTICULTURE(Fruit Science)

Compulsory courses

Course No.	Titles	Credit hr.
FSC-501	Tropical and dry land fruit production	2+1
FSC-502	Subtropical and temperate fruit production	2+1
FSC-503	Biodiversity and conservation of fruit crops	2+1
FSC-506	Breeding of fruit crops	2+1
FSC-507	Post harvest technology for horticultural crops	2+1
FSC-508	Growth and development of horticultural crops	2+1
FSC-591	Master seminar	1+0
FSC-599	Master research	0+20

Optional courses

Course No.	Titles	Credit hr.
FSC-504	Canopy management in fruit crops	1+1
FSC-505	Propagation and nursery management of horticultural crops	2+1
FSC-509	Biotechnology of horticultural crops	2+1
FSC-510	Organic horticulture	1+1
FSC-511	Protected horticulture	2+1
FSC-512	GAP for horticultural crops	1+0
FSC-513	Climate management in horticultural crops	1+0

FSC-501 : TROPICAL AND DRY LAND FRUIT PRODUCTION (2+1)

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; harvesting; industrial and export potential, Agri. Export Zones(AEZ).

Crops

UNIT I: Mango, Banana; Citrus, Papaya, Guava, Sapota, Jackfruit, Pineapple, Annonas, Avocado

UNIT II : Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing commercial orchards.

FSC-502 : SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION (2+1)

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; harvesting; industrial and export potential, Agri Export Zones(AEZ).

Crops

UNIT I: Apple, pear, quince, grapes, plum, peach, apricot, cherries, hazelnut, persimmon, walnut, almond, pistachio, pecan

UNIT II: Litchi, loquat, passion fruit, kiwifruit, strawberry, mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

FSC-503: BIODIVERSITY AND CONSERVATION OF FRUIT CROPS (2+1)

Theory

UNIT I : Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT II : Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ*.

UNIT III : Problem of recalcitrance - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT IV : Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT V : GIS and documentation of local biodiversity, Geographical indication.

Crops : Mango, citrus, banana, jackfruit, aonla, malus, *Prunus* sp, nuts, tea, garcinia, passionfruit and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

FSC-504: CANOPY MANAGEMENT IN FRUIT CROPS (1+1)

Theory

UNIT I : Canopy management - importance and advantages; factors affecting canopy development.

UNIT II Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT III Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

UNIT IV Canopy management through plant growth inhibitors and retardants, training and pruning and rejuvenation management practices.

UNIT V Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passionfruits, mango, sapota, guava, citrus and ber.

Practical

Measurement studies of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors and retardants, geometry of planting; study on effect of different canopy types on production and quality of fruits.

FSC-505 : PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Introduction, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II : Sexual propagation; Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT III : Budding and grafting – selection of elite mother plants, methods. Establishment of scion wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working .

UNIT IV : Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT V : Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Seed quality, treatment, packing, storage, certification, testing Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to commercial Tissue Culture Lab. and nurseries.

FSC-506: BREEDING OF FRUIT CROPS (2+1)

Theory

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops

UNIT I : Mango, banana and pineapple, jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT II: Citrus, grapes, guava and sapota, , litchi, jamun, phalsa, mulberry, raspberry, and nuts

UNIT III: Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding programme for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement.

FSC-507: POST HARVEST TECHNOLOGY FOR HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration of horticultural crops.

UNIT II : Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III : Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, transpiration, physical injuries and disorders.

UNIT IV : Transportation, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V : Dried and dehydrated products of horticultural crops, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of horticultural crops, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and

vegetables, cold chain management - visit to cold storage and CA storage units, visit to processing units, project preparation, evaluation of processed horticultural products.

FSC-508: GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II : Annual, semi-perennial and perennial horticultural crops, effect of light, photoperiodism, vernalisation, effect of temperature.

UNIT III : Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

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 : Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

FSC- 509: BIOTECHNOLOGY OF HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT II : Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III : Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

UNIT IV : Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V : Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Practical

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, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory.

FSC-510: ORGANIC HORTICULTURE (1+1)

Theory

UNIT I : Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT II : Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT III : EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT IV : GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT V : Constraints in certification, organic horticulture and export, IFOAM (International Federation of Organic Agriculture Movements) and global scenario of organic movement, post-harvest management of organic produce.

Practical

Features of organic orchards, working out conversion plan, Input analysis, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other 20 organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD (Bio

Dynamics) preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices.

FSC-511: PROTECTED HORTICULTURE (2+1)

Theory

UNIT I : Greenhouse – World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effects on plant growth.

UNIT II : Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

UNIT III : Interaction of light, temperature, humidity, CO₂, water on crop regulation - Greenhouse heating, cooling, ventilation and shading.

UNIT IV : Types of ventilation- Forced cooling techniques - Glazing materials – Micro irrigation and Fertigation.

UNIT V : Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases – IPM.

Practical

Designs of greenhouse, low cost poly tunnels, nethouse - Regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigation systems, special management practices, project preparation for greenhouses, visit to greenhouses.

FSC-512: GAP FOR HORTICULTURAL CROPS (1+0).

Theory

UNIT I : Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT II : Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity, profitability, and resource efficiency, harvest and post-harvest handling.

UNIT III : Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT IV : On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT V : Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP, etc. and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature.

**FSC-513: CLIMATE CHANGE AND MANAGEMENT OF HORTICULTURAL CROPS
(1+0)**

Theory

UNIT I Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO₂, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT II Sensors for climate registration bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT III Impact of climate changes on invasive insect and pest, disease, weed, yield, quality and sustainability, climate management in field production – mulching - use of plastic-windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO₂ injection - screens - artificial light.

UNIT IV Climate management for control of pests, diseases, quality, growth and other plant processes- closed production systems around the world. Special protected cultivation now and in future - growth chambers, production in space, biosphere, future aspects of closed production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

M.Sc.(Ag.) in HORTICULTURE(Vegetable Science)

Compulsory courses

Course No.	Titles	Credit hr.
VSC-501	Production technology of cool season vegetable crops	2+1
VSC-502	Production technology of warm season vegetable crops	2+1
VSC-503	Breeding of vegetable crops	2+1
VSC-504	Growth and development of horticultural crops	2+1
VSC-509	Post harvest technology for horticultural crops	2+1
VSC-591	Master seminar	1+0
VSC-599	Master research	0+20

Optional courses

Course No.	Titles	Credit hr.
VSC-505	Seed production technology of vegetable crops	2+1
VSC-506	Systematic vegetable crops	1+1
VSC-507	Production technology of unexploited vegetable crops	1+1
VSC-508	Organic horticulture	1+1
VSC-510	Protected horticulture	2+1
VSC-511	GAP for horticultural crops	1+0
VSC-512	Climate management in horticultural crops	1+0

VSC-501: PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS (2+1)

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.

VSC-502: PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS (2+1)

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.

VSC-503: BREEDING OF VEGETABLE CROPS (2+1)

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.

VSC-504: GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS (2+1)

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 abscissic 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.

VSC-505: SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS (2+1)

Theory

UNIT I : Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT II : 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.

UNIT III : 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 VI : 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.

UNIT V : Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetative propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

VSC-506: SYSTEMATIC OF VEGETABLE CROPS (1+1)

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 and temperate vegetables.

UNIT III : Cytological level of various vegetable crops; descriptive keys for important vegetables.

UNIT IV : Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

VSC-507: PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS (2+1)

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.

VSC-508: ORGANIC HORTICULTURE (1+1)

Theory

UNIT I : Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT II : Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT III : EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT IV : GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT V : Constraints in certification, organic horticulture and export, IFOAM (International Federation of Organic Agriculture Movements) and global scenario of organic movement, post-harvest management of organic produce.

Practical

Features of organic orchards, working out conversion plan, Input analysis, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other 20 organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD (Bio Dynamics) preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices.

VSC-509: POST HARVEST TECHNOLOGY FOR HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT II : Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III : Treatments prior to shipment, *viz.*, chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV : Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V : Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

VSC-510: PROTECTED HORTICULTURE (2+1)

Theory

UNIT I : Greenhouse – World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effects on plant growth.

UNIT II : Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

UNIT III : Interaction of light, temperature, humidity, CO₂, water on crop regulation - Greenhouse heating, cooling, ventilation and shading.

UNIT IV : Types of ventilation- Forced cooling techniques - Glazing materials – Micro irrigation and Fertigation.

UNIT V : Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases – IPM.

Practical

Designs of greenhouse, low cost poly tunnels, nethouse- Regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigation systems, special management practices, project preparation for greenhouses, visit to greenhouses.

VSC-511: GAP FOR HORTICULTURAL CROPS (1+0)

Theory

UNIT I : Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT II : Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.

UNIT III : Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT IV : On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT V : Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP, etc.

VSC-512: CLIMATE MANAGEMENT IN HORTICULTURAL CROPS (1+0)

Theory

UNIT I : Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO₂, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT II : Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT III : Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic-windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO₂ injection - screens - artificial light.

UNIT IV : Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of closed production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

M.Sc.(Ag.)in HORTICULTURE(Floriculture and Landscape Architecture)

Compulsory courses

Course No.	Titles	Credit hr.
FLA-501	Breeding of flower crops and ornamental plants	2+1
FLA-502	Production technology of cut flowers	2+1
FLA-503	Production technology of loose flowers	2+1
FLA-504	Landscaping and ornamental gardening	2+1
FLA-506	Post harvest technology for horticultural crops	2+1
FLA-507	Turfing and turf management	2+1
FLA-510	Growth and development of horticultural crops	2+1
FLA-591	Master seminar	0+1
FLA-599	Master research	0+20

Optional courses

Course No.	Titles	Credit hr.
FLA-505	Protected horticulture	2+1
FLA-508	Propagation and nursery management of horticultural crops	2+1
FLA-509	Biotechnology of horticultural crops	2+1
FLA-511	Organic horticulture	1+1
FLA-512	GAP for horticultural crops	1+0
FLA-513	Climate management in horticultural crops	1+0

FLA-501: BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS (2+1)

Theory

UNIT I : Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India.

UNIT II : Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life.

UNIT III : Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

UNIT IV : Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliiums, nerium.

UNIT V : Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliage-- Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

FLA-502: PRODUCTION TECHNOLOGY OF CUT FLOWERS (2+1)

Theory

UNIT I : Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II : Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering.

UNIT III : Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV : Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V : Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones. Crops: rose, cut chrysanthemum, carnation, gerbera, gladioli, orchids, anthurium, aster, lilioms, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, gypsophilla, limonium, statice.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

FLA-503: PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS (2+1)

Theory

UNIT I : Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques.

UNIT II : Soil and climate requirements, field preparation, systems of planting, precision farming techniques.

UNIT III : Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM.

UNIT IV : Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

UNIT V : Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agri Export Zones.

Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

Practical

Botanical description of species and varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets

FLA-504: LANDSCAPING AND ORNAMENTAL GARDENING (2+1)

Theory

UNIT I : Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II : Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

UNIT III : Garden plant components, 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, bamboo groves; Production technology for selected ornamental plants.

UNIT IV : Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

UNIT V : Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

Practical

Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders,

project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

FLA-505: PROTECTED HORTICULTURE (2 +1)

Theory

UNIT I : Prospects of protected horticulture/ floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II : Environment control – management and manipulation of temperature, light, humidity, air and CO₂; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III : Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV : Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V : Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, postharvest handling, packing methods, project preparation, visit to commercial greenhouses.

FLA-506: POST HARVEST TECHNOLOGY FOR HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration of fruits and vegetables.

UNIT II : Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III : Treatments prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV : Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V : Dried and dehydrated products of fruits and vegetables, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

FLA-507: TURFING AND TURF MANAGEMENT (2+1)

Theory

UNIT I : Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.

UNIT II : Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement-Adaptation; Turfing for roof gardens.

UNIT III : Preparatory operations; Growing media used for turf grasses – Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.

UNIT IV : Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing -- mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.

UNIT V : Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

Practical

Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices – mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic stress management; Project preparation for turf establishment, visit to IT parks, model cricket and golf grounds, airports, corporate, Govt. organizations; Renovation of lawns; Turf economics.

FLA-508: PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II : Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT III : Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT IV : Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT V : Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

FLA- 509: BIOTECHNOLOGY OF HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT II : Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III : Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

UNIT IV : Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V : Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro*

selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Practical

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, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory.

FLA-510: GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS (2+1)

Theory

UNIT I : Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II : Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III : Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

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 : Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

FLA-511: ORGANIC HORTICULTURE (1+1)

Theory

UNIT I : Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT II : Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT III : EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT IV : GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT V : Constraints in certification, organic horticulture and export, IFOAM (International Federation of Organic Agriculture Movements) and global scenario of organic movement, post-harvest management of organic produce.

Practical

Features of organic orchards, working out conversion plan, Input analysis, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other 20 organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD (Bio Dynamics) preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices.

FLA-512: GAP FOR HORTICULTURAL CROPS (1+0)

Theory

UNIT I : Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT II : Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.

UNIT III : Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT IV : On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT V : Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP, etc.

FLA-513: CLIMATE MANAGEMENT IN HORTICULTURAL CROPS (1+0)

Theory

UNIT I : Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO₂, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT II : Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT III : Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic-windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO₂ injection - screens - artificial light.

UNIT IV : Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of closed production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

M.Sc.(Ag.) in HORTICULTURE (Plantation, Spices, Medicinal & Aromatic Crops)

Compulsory courses

Course No.	Titles	Credit hr.
PSMA-501	Production technology of plantation crops	2+1
PSMA-502	Production technology of spice crops	2+1
PSMA-503	Production technology of medicinal and aromatic crops	2+1
PSMA-504	Breeding of plantation crops and spices	2+1
PSMA-505	Breeding of medicinal and aromatic crops	2+1
PSMA-506	Processing of plantation crops, spices, medicinal and aromatic crops	2+1
PSMA-591	Master's seminar	1+0
PSMA-599	Master's research	20

Optional courses

Course No.	Titles	Credit hr.
PSMA-507	Organic spice and plantation crop production technology	2+1
PSMA-508	Underexploited medicinal and aromatic plants	1+1

PSMA-501: PRODUCTION OF PLANTATION CROPS (2+1)

Theory

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including *in vitro* multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Wattle and betel vine

Practical

Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

PSMA-502: PRODUCTION TECHNOLOGY OF SPICE CROPS (2+1)

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, 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, physiological disorders, harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT I : Black pepper, cardamom

UNIT II : Clove, cinnamon and nutmeg, allspice

UNIT III : Turmeric, ginger and garlic

UNIT IV : Coriander, fenugreek, cumin, fennel, ajowain, dill, celery

UNIT V : Tamarind, garcinia and vanilla

Practical

Identification of seeds and plants, botanical description of plant; preparation of 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.

PSMA-503: PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS (2+1)

Theory

UNIT I : Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO's in production, GAP in medicinal crop production.

UNIT II : Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, *Dioscorea* sp., *Aloe vera*, *Phyllanthus amarus*, *Andrographis paniculata*.

UNIT III : Production technology for Medicinal solanum, Isabgol, Poppy, Safed musli, *Stevia rebaudiana*, *Mucuna pruriens*, *Ocimum* sp.

UNIT IV : Post harvest handling – Drying, Processing, Grading, Packing and Storage, processing and value addition; GMP and Quality standards in herbal products.

UNIT V : Influence of biotic and abiotic factors on the production of secondary metabolites, Regulations for herbal raw materials, Phytochemical extraction techniques.

UNIT VI : Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VII : Production technology for palmarosa, lemongrass, citronella, vetiver, geranium, artemisia, mentha, ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.

UNIT VIII : Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations.

UNIT IX

Institutional support and international promotion of essential oil and perfumery products.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important Aromatic crops, Visit to distillation and value addition units – Visit to CIMAP.

PSMA-504: BREEDING OF PLANTATION CROPS AND SPICES (2+1)

Theory

Species and cultivars, cytogenetics, survey, collection, conservation and evaluation, blossom biology, breeding objectives, approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploid breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, molecular aided breeding and biotechnological approaches, marker-assisted selection, bioinformatics, IPR issues, achievements and future thrusts.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Black pepper and cardamom

UNIT VI: Ginger and turmeric

UNIT VII: Fenugreek, coriander, fennel, celery and ajwain

UNIT VIII: Nutmeg, cinnamon, clove and allspice

Practical

Characterization and evaluation of germplasm accessions, Blossom biology, studies on pollen behaviour, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for biotic and abiotic stresses, haploid culture, protoplast culture and fusion- induction of somaclonal variation and screening the variants. Identification and familiarization of spices; floral biology anthesis; fruit set; selfing and crossing techniques; description of varieties. Salient features of improved varieties and cultivars from public and private sector, bioinformatics, visit to radiotracer laboratory, national institutes for plantation crops and plant genetic resource centers, genetic transformation in plantation crops for resistance to biotic stress/quality improvement etc.

PSMA-505: BREEDING OF MEDICINAL AND AROMATIC CROPS (2+1)

Theory

UNIT I : Plant bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops; Scope for improvement of Medicinal and Aromatic Crops through selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches.

UNIT II : Breeding for yield and quality improvement in medicinal plants, Breeding for high herbage yield, essential oil and quality components, secondary metabolites in medicinal and aromatic crops; Genetics of active principles and assay techniques useful in evaluation of

breeder's material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

UNIT III : Achievements and prospects in breeding of medicinal crops, viz. *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, Stevia, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, *Dioscorea* sp.

UNIT IV : Prospects in breeding of medicinal crops, viz. *Chlorophytum* sp, *Rauwolfia serpentina*, *Aloe vera*, *Ocimum* sp, *Phyllanthus amarus*, *Solanum* sp.

UNIT V : Prospects in breeding of aromatic crops viz., Geranium, vetiver, Lemon grass, Palmarosa, citronella, Rosemary, Patchouli, Eucalyptus, Artemisia and Mint.

Practical

Description of Botanical features, Cataloguing of cultivars, varieties and species in medicinal and aromatic crops, Floral Biology, Selfing and crossing, Evaluation of hybrid progenies, Induction of economic mutants, High alkaloid and high essential oil mutants, evolution of mutants through physical and chemical mutagens, Introduction of polyploidy, Screening of plants for biotic and abiotic stress and environmental pollution, *in-vitro* breeding in medicinal and aromatic crops.

PSMA-506: PROCESSING OF PLANTATION CROPS, SPICES MEDICINAL AND AROMATIC CROPS (2+1)

Theory

UNIT I : Commercial uses of spices and plantation crops. Processing of major spices - cardamom, black pepper, ginger, turmeric, chilli and paprika, vanilla, cinnamon, clove, nutmeg, allspice, coriander, fenugreek, curry leaf. Extraction of oleoresin and essential oils.

UNIT II : Processing of produce from plantation crops, viz. coconut, arecanut, cashewnut, oil palm, palmyrah, date palm, cocoa, tea, coffee, rubber etc.

UNIT III : Processing of medicinal plants– dioscorea, gloriosa, stevia, coleus, ashwagandha, tulsi, isabgol, safed musli, senna, aloe, catharanthus, etc. Different methods of drying and storage. Microbial contamination of stored product. Influence of temperature and time combination on active principles.

UNIT IV : Extraction and analysis of active principles using TLC / HPLC / GC. Distillation, solvent extraction from aromatic plants– davana, mint, rosemary, rose, citronella, lavender, jasmine, etc. Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

Practical

Study of processing of different spices and plantation crops. Study of processing of medicinal plants, their drying and storage. Extraction of active ingredients from different spices and herbs using TLC, HPLC, GC/MS technology. Distillation, solvent extraction from aromatic plants – davana, mint, rosemary, citronella, lavender, jasmine, etc. Identification of different odoriferous factors in essential oil with GLC/GCMS. Physico-chemical and sensory evaluation of oils and oleoresin. Value added products from spices and plantation crops.

PSMA-507: ORGANIC SPICE AND PLANTATION CROP PRODUCTION TECHNOLOGY (2+1)

Theory

UNIT I : Importance, principles, perspective, concept and component of organic production of spice and plantation crops.

UNIT II : Organic production of spice crops and plantation crops, *viz.* pepper, cardamom, turmeric, ginger, cumin, vanilla, coconut, coffea, cocoa, tea, arecanut.

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

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

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

Practical

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

PSMA-508: UNDEREXPLOITED MEDICINAL AND AROMATIC CROPS (1+1)

Theory

UNIT I : Introduction, importance, present status and future prospects, origin, distribution, species, varieties, economic parts and their uses in different diseases, Biodiversity and conservation, RET (Rare, Endangered and Threatened) and MPCAs (Medicinal Plants Conservation Areas).

UNIT II : Underutilized species – importance, traditional usage, ISM, TCM, Functional foods.

UNIT III : Production technology of underutilized medicinal crops– *Morindacitrifolia*, *Caesalpinia sappan*, *Caralluma*, *Terminalia chebula*, *Strychnosnuxvomica*, *Solanum trilobatum*, *Physalis*, *Aegle marmelos*, *Alpinia sp.*, *Anthocephalus kadamba*, *Costus*.

UNIT IV : Production technology of underutilized aromatic crops– *Curcumaaromatica*, *C. caesia*, *Coleus aromaticus*, *Ocimum kilimanjaricum*, *Bursera*.

UNIT V : National and international conservation network, IPR issues, Promotion of underutilized species, Processing and value addition, Marketing.

Practical: Case studies.