



Regd. No. 246 / 94

ICAR – KRISHI VIGYAN KENDRA

HANS ROEVER CAMPUS
VALIKANDAPURAM, PERAMBALUR
TAMILNADU 621115



NOTICE

Written Examination for Recruitment of Various Posts

This is to inform that, all concerned candidates that the **Written Examination** for recruitment to the following posts under **Krishi Vigyan Kendra (KVK)** will be conducted as per the schedule given below:

Assistant	Subject Matter Specialist (SMS) – Horticulture
Examination Schedule	Examination Schedule
Date : 10/09/2026	Date : 10/09/2026
Reporting Time : 10.00 AM	Reporting Time : 11.30 AM
Examination Time : 10.30 - 11.30 AM	Examination Time : 12.00 - 01.00 PM
Venue : Hans Roever Krishi Vigyan Kendra, Valikandapuram, Perambalur	

Candidates who have applied for the above posts are advised to appear for the written examination as per the schedule mentioned above.

Candidates must bring their **Call Letter** and a **valid Photo Identity Proof** to the examination centre. Candidates are advised to report well in advance of the commencement of the examination.

All candidates are requested to strictly follow the instructions issued by the examination authority. Any further information regarding the recruitment process will be notified through the official website.

Note: Candidates are advised to regularly visit the official website for further updates and notifications regarding the recruitment.

Date: 25.08.2026


(M.PUNITHAVATHI)
SENIOR SCIENTIST & HEAD
Hans Roever Krishi Vigyan Kendra
ICAR-ATARI, Zone X
Perambalur-Dt. Tamilnadu-621 115

Exam Pattern

Position	Assessment Stage	Subject Domain / Exam Content	Total Questions	Maximum Marks	Exam Duration
Assistant	Stage 1: Written Exam	General Intelligence & Reasoning, Quantitative Aptitude, General Awareness, English Comprehension	50 Questions	50 Marks	60 Minutes
SMS Horticulture	Stage 1: Written Exam	Floriculture & Landscaping, Fruit Science, Spices, Plantation & Medicinal & Aromatic Plants, Vegetable Science	50 Questions	50 Marks	60 Minutes


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Syllabus for the both post

Syllabus for Assistant Grade Examination:

(A) General Intelligence & Reasoning:

It would include questions of both verbal and non-verbal type. This component may include questions on analogies, similarities and differences, space visualization, spatial orientation, problem solving, analysis, judgment, decision making, visual memory, discrimination, observation, relationship concepts, arithmetical reasoning and figural classification, arithmetic number series, non-verbal series, coding and decoding, statement conclusion, syllogistic reasoning etc. The topics are, Semantic Analogy, Symbolic/ Number Analogy, Figural Analogy, Semantic Classification, Symbolic/ Number Classification, Figural Classification, Semantic Series, Number Series, Figural Series, Problem Solving, Word Building, Coding & de-coding, Numerical Operations, symbolic Operations, Trends, Space Orientation, Space Visualization, Venn Diagrams, Drawing inferences, Punched hole/ pattern- folding & un-folding, Figural Pattern-folding and completion, Indexing, Address matching, Date & city matching, Classification of centre codes/ roll numbers, Small & Capital letters/ numbers coding, decoding and classification, Embedded Figures, Critical thinking, Emotional Intelligence, Social Intelligence.

(B) General Awareness:

Questions in this component will be aimed at testing the candidates' general awareness of the environment around him and its application to society. Questions will also be designed to test knowledge of current events and of such matters of every day observations and experience in their scientific aspect as may be expected of any educated person. The test will also include questions relating to India and its neighbouring countries especially pertaining History, Culture, Geography, Economic Scene, General Policy & Scientific Research.

(C) Quantitative Aptitude:

The questions will be designed to test the ability of appropriate use of numbers and number sense of the candidate. The scope of the test will be computation of whole numbers, decimals, fractions and relationships between numbers, Percentage. Ratio & Proportion, Square roots, Averages, Interest, Profit and Loss, Discount, Partnership Business, Mixture and Alligation, Time and distance, Time & Work, Basic algebraic identities of School Algebra & Elementary surds, Graphs

of Linear Equations, Triangle and its various kinds of centres, Congruence and similarity of triangles, Circle and its chords, tangents, angles subtended by chords of a circle, common tangents to two or more circles, Triangle, Quadrilaterals, Regular Polygons, Circle, Right Prism, Right Circular Cone, Right Circular Cylinder, Sphere, Hemispheres, Rectangular Parallelepiped, Regular Right Pyramid with triangular or square base, Trigonometric ratio, Degree and Radian Measures, Standard Identities, Complementary angles, Heights and Distances, Histogram, Frequency polygon, Bar diagram & Pie chart.

(D) English Comprehension:

Candidates' ability to understand correct English, his/ her basic comprehension and writing ability, etc. would be tested.


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Syllabus for SMS Horticulture Grade Examination:

1. FLORICULTURE & LANDSCAPING

UNIT 1:

Systematics of Ornamental Plants Nomenclature: History, origin, plant diversity hotspots, plant classification and nomenclature systems, phylocode, International systems: International Code, Treaties, International and National Organizations, Biodiversity Act, Plant identification features, keys and methods; plant descriptors. Red Data Book, Registration authorities (NBPGR, PPVFRA, NBA) Families: Description of families, viz., Rosaceae, Asteraceae, Caryophyllaceae, Orchidaceae, Aracaceae, Liliaceae, Acanthaceae, Palmaceae, Asparagaceae, Malvaceae, Musaceae, Oleaceae, Iridaceae and important genera. Cryopreservation, Role of Molecular Techniques in Modern plant Systematics.

UNIT 2:

Breeding of Ornamental Crops Principles of plant breeding, Evolution, origin, distribution and conservation of ornamental genetic resources, Genetic divergence and varietal wealth, Patents, Intellectual Property Rights (IPR) and Plant Breeders Rights (PBR): Introduction and initiatives in IPR and PBR of ornamental crops and Plant Variety Protection in India. Genetic mechanism and inheritance of flower colour, doubleness, flower size, fragrance, plant architecture, post-harvest life; abiotic and biotic stress tolerance/ resistance. Breeding methods suitable for sexually and asexually propagated, self and crosspollinated flower crops and ornamental plants-Introduction, selection, domestication, hybridization, pedigree selection, backcross method, clonal selection, heterosis & F1 hybrids, polyploidy and mutation breeding for varietal development. Role of biotechnology in improvement of flower crops including transgenics, somaclonal variation, in-vitro mutagenesis, in-vitro selection, genetic engineering, molecular markers, etc. Role of heterosis, production of hybrids, reproductive barriers-Male sterility, Incompatibility, Breeding objectives, constraints and achievements made in commercial flower crops - rose, jasmine, chrysanthemum, marigold, gaillardia, tuberose, crossandra, carnation, dahlia, gerbera, gladiolus, orchids, anthurium, aster, liliuhibiscus, bougainvillea, nerium, flowering annuals (petunia, zinnia, dianthus, snapdragon, pansy, stock, calendula, balsam, annual dahlia)

UNIT 3.

Commercial Production of Cut Flowers National and International Scenario of cut flower production, Scope and importance of cut flower trade, Cut flower production problems in India (constraints); patent rights, Nursery management media for nursery raising, special nursery practices; Growing environment- open field and protected cultivation, Soil analysis, soil health card, soil/media requirements, land preparation, planting methods, influence of environmental parameters (light, temperature, moisture, humidity and CO₂), microclimate management for growth and flowering; Commercial cut flower production - Commercial varieties, water integrated nutrient management (INM), 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, production for exhibition purposes; Flower Regulation-Flower forcing and year round/ off-season flowering through physiological, chemical interventions, and environmental manipulation; Cut flower standards and grades, harvest indices, harvesting techniques, postharvest handling, methods of delaying flower opening, pre-cooling, pulsing, packing, storage & transportation, marketing, export potential of cut flower crops, institutional support, Agri Export Zones; 100% Export Oriented units in India, Crop Insurance, flower auction centre. Flower crops: Rose, chrysanthemum, carnation, gerbera, gladiolus, tuberose, orchids, anthurium, chinaaster, liliu, bird of paradise, heliconia, alstroemeria, dahlia, gypsophilla, solidago, limonium, stock, cut green foliages and fillers.

UNIT 4.

Commercial Production of Loose Flowers Scope, scenario and importance of loose flower crops, constraints and opportunities in loose flower production. Growing Environment-nursery management, pro-tray nursery under shade nets, Soil and climate requirements, field preparation, systems of planting, precision farming techniques; Soil analysis, soil health card, Water management, weed management, special horticultural practices such as ratooning, training and pruning, pinching and disbudding, etcrole of growth regulators in growth and flowering, physiological disorders and remedies, INM, IPM and IDM. Crop regulation. Flower forcing and year round/ off-season flowering, production for special occasions, through physiological interventions, chemical regulation; Post harvest management-Harvest indices, harvesting techniques, post-harvest handling and grading, packing and storage, transportation and marketing including important Indian flower markets, export potential, HPMC, APMC and online flower trading, institutional support, Crop Insurance. Flower crops -Jasmine, rose, chrysanthemum, marigold, aster, gaillardia, tuberose, crossandra, Nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers- Nyctanthes(Har singar), Tabernaemontana, ixora, lotus, water lily, tecoma, michelia (champaka), spider lily, water lily, gardenia, and balsam.

UNIT 5.

Ornamental Gardening and Landscaping Gardens and components: Historical background of gardening, Importance and scope of ornamental gardening, Styles and types of ornamental gardens, formal, informal and free style gardens, types of gardens-English, Mughal, Japanese, Persian, Spanish, Italian. French, Hindu, Buddhist garden. Garden components: living components), arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, trees, shrubs, cacti and succulents, herbs, annuals/seasonals, ornamental grasses, flower borders and beds, ground covers, carpet beds, bamboo groves, bonsai, *etc.* Production technology for selected ornamental plants; Non-living components-Path, garden gate, fencing, paving and garden features like fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls, bridge, steps, ramps, lawn. Specialized gardens: vertical garden, roof garden, terrace garden, water garden, shade garden, , bog garden, sunken garden, rock garden, clock garden, color wheels, temple garden, sacred gardens (emphasis on native plants), Zen garden ; Landscape Planning-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. . 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 in landscaping. Landscape for different situations: Urban landscaping, landscaping of institutions, industries, residential areas, hospitals, roadsides, traffic islands, dam sites, IT/ SEZ parks, corporates, farm houses, children parks, public parks airports, railway station and tracks, and river banks. Bio-aesthetic planning, eco-tourism, theme parks, therapeutic gardening, xeriscaping, waterscaping.

UNIT 6.

Protected Cultivation of Flower Crops Prospects of protected floriculture in India; Types of protected structures –Greenhouses/ polyhouses, shade houses, mist chambers, lath houses, orchidarium, fernery, rain shelters etc., Principles of designing and erection of protected structures. Low cost/medium cost/high cost structures; Location specific designs; Structural components; Suitable flower crops and foliage plants for protected cultivation; Environment control - Microclimate 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; water harvesting, Intercultural Operations and Crop Regulation: Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM; Crop regulation by

chemical methods, special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc. staking and netting, Photoperiod regulation; Automation and standards: Automation in greenhouses, sensors, solar greenhouses and retractable greenhouses, GAP/ Flower labels, Export standards, EXIM policy, APEDA regulations for export, non-tariff barriers. Flower crops: Rose, Chrysanthemum, Carnation, Gerbera, Orchids, Anthuriums, Lilium, Limonium, Lisianthus, Heliconia, Cala lily, Alstromeria, etc.

UNIT 7.

Value Addition in Floriculture National and global scenario, scope and prospects of value addition, production and exports, Types of value-added products, techniques of value addition including tinting, pulsing., Value addition in loose flowers and product development such as gulkand, floral tea, rose oil, rose water, Pankhuri, floral dyes, rose sherbet, floral ice creams, sweets, garlands, veni, floats, floral decorations, etc., value addition in cut flowers such as fresh floral arrangement: Selection of containers and accessories, Flower arrangement styles, Ikebana schools (Ikenobo, Ohara, Sogetsu, etc.), Moribana, Nagiere, contemporary style /free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations; Dry flowers- identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; tips for collecting dry flower making, selection of stages for picking of flowers for drying, Techniques in dry flower making -Drying, glycerising, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement -dry flower baskets, bouquets, potpourri, wall hangings, button holes, greeting cards, wreaths; petal embedded handmade papers, Packing and storage; Post drying management including moisture, pests and moulds in value added dried products. Concrete and essential oils- Selection of species and varieties (including nonconventional species), extraction methods, packing and storage. Aromatherapy. Types of pigments carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments as nutraceuticals and pharmaceuticals; Extraction methods; Applications in food, cosmetics, pharmaceutical and poultry industries. Dying: Synthetic and Natural dyes, dying techniques, color retention.

Unit 8.

Turf grass Management History, present status and prospects of turf industry; site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment; criteria for evaluation of turf quality. Turf grasses -Types, species, varieties, hybrids; identification of turf grasses, selection of turf grasses for different locations; Grouping according to climatic requirement, adaptation, ; Turfing for roof gardens; Preparatory operations; Growing media used for turf grasses, turf establishment methods- seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, instant turfing (portable), astro-turfing, synthetic turfing; Turf management -Irrigation, drainage, nutrition, special practices such as aerating, rolling, coreaerification, dethatching, verticutting, soil top dressing, etc. Use of turf growth regulators (TGRs) and micronutrients. Turf mowing -mowing equipment, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs; standards for turf, use of recycled water for turf establishment and maintenance. Selection and maintenance of turf grasses for playgrounds, residential and public parks, turfing of Govt. and Corporate office gardens, event specific preparation, turf colourants.

UNIT 9:

Indoor Plants and Interior scaping Importance and scope: Importance and scope of indoor plants and interior scaping, Indoor plants and indoor air quality. Factors affecting growth, development and flowering of indoor plants. Classification and principles: Classification of indoor plants based on light, temperature, humidity and pollution tolerance. Description and cultivation of various indoor plants. Principles of interior scaping, Role in pollution mitigation. Cultural operations: Containers and substrates, preparation of growing media, propagation, training, grooming, nutrition, management of disease, pests and weeds. Maintenance of plants including repotting, foliar nutrition,

light exposure and plant rotation. Media standards, Nursery and Export standards for potted plants. Special gardens including miniature gardens and plant stand. Presentations like dish garden, terrarium, bottle gardens, hanging baskets, window boxes and bonsai. Vertical gardens- history, planting material, structures, containers, substrate, water and nutrient management, supplemental lighting. Marketing channels, Business models including plant rentals.

UNIT 10:

Seed Production in Flower Crops International and national scenario of flower seed production, scope, and importance of seed production in flower crops. Constraints in flower seed production. Methods of seed production, agro-techniques for production of nucleus, breeder and certified seeds. Harvesting, seed processing, seed priming, seed chain, packaging and storage; Mass selection, progeny selection, use of incompatibility and male sterility, maintenance of variety and seed production in flower crops; F1 hybrid seed production advantages, steps involved in hybrid seed production, pollination behaviour and isolation, pollination management methods in production of F1/ hybrids in different flower crops; Seed certification, Seed standards, seed act, plant breeders rights and farmers' rights, Bio safety, handling of transgenic seed crops, importing of seeds and OGL, trade barriers in seed business, sanitary and phytosanitary issues, custom clearance and quarantine. Marketing and economics of flower seeds; Flower crops: Marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, vinca, dianthus, sunflower, annual chrysanthemum, poppy, corn flower, rice flower, aster, annual dahlia, crossandra and gaillardia.

Unit 11.

Computer Aided Design (CAD) for Landscaping Principles of integrating the architecture and landscaping, Exposure to CAD (Computer Aided Design) -Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software. Creating legends for plant and non-plant components. Basics of Photoshop software in garden designing; 2D drawing methods AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects; Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking Script making, Using productivity tools, e- transmit file, Making layout; 3D drawing methods, ARCHICAD file system, Tools and Info box, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD; ARCHICAD organization tools, Dimensioning and detailing of designs, Landscape designing softwares and CD ROM for ornamental plant material (TRES, HIMFLORA, CAPSSA, etc), Attribute settings of components, Visualization tools for landscape preview, Inserting picture using Photoshop.

2. FRUIT SCIENCE

Unit 1.

Tropical Fruit Production Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstocks, stionic influence, planting systems, cropping systems, root zone and canopy management, nutrient and water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees/pollinators in cross pollination, physiological disorders causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques, processing and value addition, industrial and export potential, Agri Export Zones (AEZ) and industrial supports, Canopy management through plant growth inhibitors, training and pruning and management practices in relation to growth, flowering, fruiting and fruit quality, insect and disease management, Integrated Nutrient Management (INM), bio- fertilizers and fertigation in tropical fruit crops, organic fruit

production, pre-harvest and post-harvest factors affecting shelf-life of fruits. Crops: mango, banana, citrus, papaya, guava, sapota, jackfruit, pineapple, Annona, avocado, aonla, pomegranate and ber.

Unit 2.

Subtropical and Temperate Fruit Production Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstocks, stionic influences, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, pollinizers, pollinators, fruit set and development, abiotic factors limiting production, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; processing and value addition, industrial and export potential, Agri Export Zones (AEZs) and industrial support, Canopy management through plant growth inhibitors, training and pruning and management practices in relation to growth, flowering, fruiting and fruit quality, insect and disease management, pre harvest and post-harvest factors affecting shelf life. Crops: apple, pear, quince, grapes, plums, peach, apricot, cherries, litchi, loquat, persimmon, kiwifruit. strawberry, nuts (walnut, almond, pecan).

Unit 3.

Breeding of Fruit Crops Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes, approaches for crop improvement — introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, breeding for biotic and abiotic stresses, biotechnological interventions and achievements. Intellectual Property Rights (IPR) and Plant Breeders Rights (PBR): Introduction and initiatives in fruit crops. Crops: mango, banana, pineapple, citrus, grapes, guava, sapota, jackfruit, papaya, custard apple, aonla, avocado, ber, mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam, apple, pear, plums, peach, apricot, cherries, strawberry and nuts, pomegranate and kiwi fruit.

Unit 4.

Growth and Development of Fruit Crops Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis; 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; Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, morphactins, role of plant growth promoters and inhibitors; Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization, fruit set, fruit drop, fruit growth, ripening and seed development; 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, global warming, effect of climate change on spatiotemporal patterns of temperature and rainfall, concentrations of greenhouse gasses in atmosphere. 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 and artificial light. Impact of climate changes on invasive insects, diseases, weeds, fruit yield, quality and sustainability.

Unit 5.

Biotechnology of Fruit Crops Harnessing biotechnology in horticultural crops; introduction and significance, history and basic principles, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture; callus culture - types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; use of bioreactors and in-vitro methods - for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, acclimatization of tissue culture plants; Physiology of hardening - hardening and field transfer, organ culture - meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion; Somatic cell hybridization construction and identification of somatic hybrids and cybrids, wide hybridization, invitro pollination and fertilization, haploids, in- vitro mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering- principles and methods, and transformation in horticulture crops, use of molecular markers and genomics. Gene silencing, gene tagging, gene editing in fruit crops. In-vitro selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Unit 6.

Propagation and Nursery Management in Fruit Crops 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. Conventional asexual propagation: Cutting– methods, rooting of soft, semi-hard 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. Budding and grafting – principles and methods, graft union formation, establishment and management of scion/bud wood bank. Stock, scion and inter stock relationship– graft incompatibility, physiology of rootstock and top working. Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micro-grafting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules. 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, quarantine, role of Post-Entry Quarantine (PEQ), and Clean Plant Programme (CPP).

Unit 7.

Systematics of Fruit Crops Nomenclature and classification: Biosystematics – introduction and significance; history of nomenclature of cultivated plants, classification and nomenclature systems; International code of nomenclature for cultivated plants. Identification and description: methods of identification and description of cultivated fruit and nut species and their wild relative; development of plant keys for systematic identification and classification. Development of fruit crop descriptors- based upon Biodiversity International Descriptors and UPOV/ DUS test guidelines, botanical and pomological description of major cultivars and rootstocks of tropical, subtropical and temperate fruits and nut crops. Registration and modern systematics: GI and Farmers variety Registration, Use of chemotaxonomy, biochemical and molecular markers in modern systematics.

Unit 8.

Export Oriented Fruit Production 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, 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. Processed and value-added products, post-

harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; FPO license, role of APEDA, FSSAI, BIS, WTO and its implications, sanitary and phyto-sanitary measures, MRLs. 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. Seed and planting material; meeting export standards, implications of plant variety protection – patent regimes.

Unit 9.

Minor Fruit Production 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, marketing; minor fruit crops in terms of nutritional and pharmaceutical values; their uses for edible purpose and in processing industry Crops: Bael, chironji, fig, passion fruit, jamun, phalsa, karonda, wood apple, cactus pear, khejri, kair, pilu, lasoda, loquat, tamarind, dragon fruit, monkey jack, mahua, khirni, amra, kokum, cape gooseberry, kaphal, persimmon, pistachio, sea buckthorn, hazel nut and other minor fruits of regional importance.

Unit 10.

Post-Harvest Management of Fruit Crops Post-harvest management scenario of India and world, fruit maturity indices, harvesting practices in tropical, sub-tropical and temperate fruits, influence of pre-harvest practices, Climacteric and non-climacteric fruits, enzymatic and textural changes, respiration, transpiration during fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest losses, precooling; Treatments prior to shipment, viz., pre-cooling, chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage-ventilated, refrigerated, MAS, CA storage, physical injuries and post-harvest and storage disorders; fruit ripening chambers, Packing methods and transport, principles and methods of preservation, Principles of food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies; Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology of value-added products, processing waste management, food safety standards.

3. SPICES, PLANTATION & MEDICINAL & AROMATIC PLANTS

Unit 1.

Production of Plantation Crops Role of plantation crops in national economy, export potential, role of commodity boards and developmental activities, IPR issues, clean development mechanism, classification, wild species, varietal wealth, DUS and molecular characterization, conservation of biodiversity. Plant multiplication including in vitro multiplication, systems of cultivation, multitier cropping, cropping systems, 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, organic production methods, training and pruning, crop regulation, growth and development, developmental physiology, plant protection, maturity indices, harvesting, mechanized harvesting, post-harvest handling, primary processing, processing and value addition. Cost benefit analysis, organic farming, management of drought and precision farming. Crops: Coffee, tea, cashew, cocoa, rubber, palmyrah, oil palm, coconut, areca nut and betel vine.

Unit 2.

Production Technology of Spice Crops Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, role of spices board and other development agencies, IPR issues, classification of spices – major minor, tree, seed, herbal spices, botany and taxonomy, wild species, DUS and molecular characterization, conservation of

biodiversity, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, propagation and nursery management, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, organic production methods, mulching, growth and development, developmental physiology, physiological disorders, maturity indices, harvesting, mechanized harvesting, post-harvest management, primary processing, processing and value addition, different kinds of packing material, containers, equipment, labeling, packing and storage of the processed produce, 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: Black pepper, small and large cardamom, clove, cinnamon, nutmeg, allspice, turmeric, ginger, garlic, coriander, fenugreek, cumin, fennel, ajwain, tamarind, garcinia and vanilla.

Unit 3.

Production of Medicinal and Aromatic Crops Importance of medicinal and aromatic plants in human health, area, production, national economy and related industries, problems, prospects and challenges, role of medicinal plants board and NGOs in R&D, IPR issues, Indian system of medicine, medicinal industries, sources of medicinal plants, export and import, taxonomy, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge. Indian perfumery industry, important constituents of medicinal and aromatic crops, physical and chemical properties of aromatic crops. Climate and soil requirements, wild species varietal wealth, DUS and molecular characterization, conservation of biodiversity, propagation through seed, vegetative and micropropagation, nursery techniques and management, site selection, layout, sowing/planting, nutrition and irrigation management, intercropping, mixed cropping, mulching, organic production methods, growth and development, developmental physiology, plant protection, yield, harvest indices, harvesting methods, post harvest handling, primary processing, processing, study of aroma compounds, extraction, grading, packing, storage, value addition and quality standards in herbal products, GAP, GMP certification, Extraction and analysis of active principles using TLC/HPLC/GC of medicinal plants (*Senna*, *periwinkle*, medicinal *coleus*, *ashwagandha*, *glory lilly*, *Dioscorea* sp. *Digitalis*, medicinal *Solanum*, *Mucuna pruriens*, *Plumbago zeylanicum*, *Piper longum*, *Isabgol*, *Rauwolfia*, *Poppy*, *Aloe vera*, *Stevia*, *Safed Musli*, *Kalmegh*,); and aromatic plants (*Citronella*, *Palmarosa*, *Mentha*, *Lemongrass*, *Patchouli*, *Geranium*, *vetiver*, *sweet flag*, *jasmine*, *lavender*, *Artemisia*, *Ocimum* sp., *Eucalyptus*, *sandal wood*). Underexploited crops: *Flacourtia montana*, *Plectranthus aromaticus*, *Adhatoda* sp, *Hemidesmus indicus*, *Tinospora cordifolia*, *Gymnema sylvestra*, *Morinda citrifolia*, *Bursera* sp, *Commiphora wightii*, *Ocimum kilimandjaricum*.

Unit 4.

Breeding of Plantation Crops and Spices Species and cultivar diversity, floral and reproductive biology, cytogenetics, male sterility, incompatibility, varieties, survey, collection, conservation and evaluation of germplasm, breeding objectives on the basis of yield, quality, stress tolerance, adaptation, 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, bio- informatics, breeding for climate resilience, IPR issues, achievements and future thrusts. Crops: Coffee, tea, cashew, cocoa, rubber, palmyrah palm, oil palm, betel vine, coconut, arecanut, black pepper, cardamom, ginger, turmeric, fenugreek, coriander, fennel, cumin, celery, ajwain, garlic, nutmeg, cinnamon, clove, garcinia, tamarind and allspice.

Unit 5.

Breeding of Medicinal and Aromatic Crops Plant bio-diversity, survey, collection, conservation and evaluation of germplasm, IPR issues, floral and reproductive biology, cytogenetics, male sterility, incompatibility, Breeding problems, genetics of active principles. Major objectives of breeding of

Medicinal and Aromatic Crops for yield, quality, stress tolerance, adaptation, herbage yield, essential oils, secondary metabolites, 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; Assay techniques useful in evaluation of breeder's material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops: Achievements in terms of varieties, parentage, salient features, molecular breeding, biotechnological approaches, marker assisted selection, bioinformatics and prospects in breeding of medicinal crops, viz. *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, *Stevia rebaudiana*, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, , *Piper longum*, *Plumbago zeylanica*, *Aloe vera*, *Rauvolfia serpentina*, *Chlorophytum* sps. *Geranium*, *Vetiver*, *Lemon grass*, *Palmarosa*, *Citronella*, *Kaempferia galanga*, *Patchouli*, *Lavender*, *Ocimum* sp., *Eucalyptus*, *Artemisia* and *Mint*.

Unit 6.

Systematics of Plantation, Spice, Medicinal and Aromatic Crops Centre of origin, distribution, taxonomical status, phylogeny; botany, cytology, ploidy status, sex forms, flowering and pollination biology and cytogenetics; wild and related species, cultivars, indigenous and exotic germplasm; descriptors, DUS guidelines, molecular aspects of systematics of: Plantation crops: Coconut, oil palm, cocoa, arecanut, tea, coffee, betel vine, cashew, rubber Spice crops: Black pepper, cardamom, ginger, turmeric, clove cinnamon, nutmeg, vanilla, garlic, coriander, fennel, fenugreek, cumin Medicinal crops: Opium poppy, isabgol, ashwagandha, senna, medicinal coleus, glory lilly, periwinkle, sarpagandha, long pepper, *Stevia*, safed musli, *Plumbago zeylanica* Aromatic crops: Lemon grass, citronella, palmarosa, vetiver, *Geranium*, patchouli, mint, *Ocimum*, lavender, rosemary eucalyptus, *Kaempferia galanga*.

Unit 7.

Growth and Development of Plantation, Spice, Medicinal and Aromatic Crops Growth, development, assimilate partitioning and plant bio regulators; Growth and development, definitions, components, photosynthetic productivity, different stages of growth, growth curves, growth analysis, morphogenesis; Growth pattern in annual, semi- perennial and perennial crops, growth dimorphism, environmental impact on growth and development: effect of light, temperature, photoperiod; Assimilate partitioning: Assimilate partitioning during growth and development, influence of water and mineral nutrition. Canopy management for conventional and high density planting pruning, training, chemicals, crop regulation for year-round and off-season production; Plant bio regulators: plant bio regulators- auxins, gibberellins, cytokinins, ethylene, inhibitors and retardants, basic functions, biosynthesis and role in crop growth and development; Developmental physiology and biochemistry during dormancy, bud break, juvenility; Physiology of flowering, photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism, pollination, fertilisation, fruit set, fruit drop, fruit growth, ripening, seed development; Growth and development process during stress, production of secondary metabolites, molecular and genetic approaches in growth and development.

Unit 8.

Biochemistry of Plantation, Spice, Medicinal and Aromatic Crops Maturity indices, changes during ripening, processing, factors affecting quality. Secondary metabolites and their biosynthetic pathways, factors affecting production of secondary metabolites; Contaminants: Adulterants, and substitutes, sources of contamination microbial, heavy metal, pesticide residues; Value added products: Fixed oils, essential oils, dyes, oleoresins, aroma chemicals and other value added products, their content, storage, medicinal and pharmacological properties, use in the food, flavour perfumery and pharmaceutical industries; Quality standards of raw materials and finished products; Basic and advanced extraction techniques - Soxhlet, SCFE, Membrane extraction. Chemical characterization- HPTLC, GCMS, LCMS, NMR; Plant tissue cultures in the industrial production of bioactive plant metabolites. Cell suspension culture systems for large scale culturing of plant

cells and production of secondary metabolites. Advantages of cell culture over conventional extraction techniques.

4. VEGETABLE SCIENCE

Unit 1.

Production of Cool Season Vegetable Crops Introduction, botany and taxonomy, classification of cool season vegetable crops, scope , importance and problems of cool season vegetable crop production, nutritional composition, cropping systems, precision farming in cool season vegetable crops, 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, plant protection measures, harvesting, post-harvest management and economics of production of potato; cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts, winter squash (zucchini), carrot, radish, turnip, beetroot, onion, garlic, peas, French bean, broad bean and green leafy vegetables (spinach, palak, fenugreek and coriander).

Unit 2.

Production of Warm Season Vegetable Crops Introduction, scope, importance and problems of warm season vegetable crop production, Classification of warm season vegetable crops, nutritional composition, cropping systems, precision farming in warm season vegetable crops, 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 economics of production of tomato, eggplant, hot and sweet peppers, okra, lab beans, cowpea, cluster bean, cucumber, bitter gourd, bottle gourd, ridge gourd, snake gourd, sponge gourd, water melon, musk melon, pumpkin, squashes, tapioca, sweet potato, green leafy vegetables (amaranthus, sorrel, rosella and portulaca) and moringa.

Unit 3.

Breeding of Vegetable Crops History and evolutionary aspects of vegetable breeding, origin, botany, taxonomy, genetic resources, wild relatives, cytogenetics, genetics, breeding objectives, pollination and fertilization mechanisms, techniques of selfing and crossing; Breeding systems; breeding methods for self and cross pollinated vegetables (introduction, selection, pedigree, hybridization, mutation and polyploidy breeding), heterosis breeding- types, mechanisms and basis of heterosis, inbreeding depression, facilitating mechanisms like male sterility, self-incompatibility and sex forms; varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, synthetic breeding, Speed breeding, rootstock breeding, biofortification, parthenocarpy, improvement of asexually propagated vegetable crops, breeding for protected environment; ideotype breeding; doubled haploid technique, gene pyramiding, pre-breeding, molecular marker, genomics, genome editing, marker assisted breeding and QTLs, biotechnology, and their use in breeding, Issue of patenting, PPV& FR Act, varietal release procedure; DUS testing in vegetable crops; potato, tomato, eggplant, hot pepper, sweet pepper, okra, peas and beans, amaranth, chenopods and lettuce, fenugreek, coriander, gourds, melons, pumpkins and squashes, cabbage, cauliflower, brussels sprout, broccoli, carrot, beetroot, radish, onion, sweet potato, taro, yam and tapioca.

Unit 4.

Growth and Development of Vegetable Crops Cellular structures and their functions; definition of growth and development, phases of growth, growth analysis and its importance in vegetable production; Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; role of auxins, gibberellins, cytokinins ethylene, abscisic acid and brassinosteroids; application of synthetic

hormones, plant growth retardants and inhibitors for various purposes in vegetable crop, role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production; Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops including cucurbits; apical dominance; physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; vernalisation, photoperiodism, phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening; plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops. Checking flower and fruit drops and improving fruit set in Solanaceous vegetables.

Unit 5:

Seed Production of Vegetable Crops Introduction; Seed history of vegetable seed production, definition of seed and its quality, modes of propagation in vegetables; Seed morphology, development and maturation in vegetable seeds; Apomixis and fertilization; Modes of propagation and reproductive behavior; Pollination mechanisms and sex forms in vegetables; Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production; Seed village concept. Floral biology; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production; Classification based on growth cycle and pollination behavior; methods of seed production, TPS (true potato seed) , comparison between different seed production methods; seed multiplication ratios and replacement rate in vegetables; pollination mechanisms; sex types, ratios and expression and modification of sex and flowering pattern in cucurbits; nursery raising and transplanting stage; Seed production technology of vegetables viz., solanaceous, cucurbitaceous, leguminous, malvaceous, Cole crops, leafy vegetables, root, tuber and bulb crops and seed spices; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato, sweet potato, Colocasia, tapioca; seed-plot technique in potato tuber seed production; hybrid seed production technology of vegetable crops, and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self-incompatibility in hybrid seed production, environmental factors related to flowering/bolting in vegetable crops; generation system of seed multiplication; maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds; seed quality and mechanisms of genetic purity testing. 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; field and seed standards, importance and present status of vegetable seed industry and share of vegetable seeds in seed industry; intellectual property rights and its implications, impact of PVP on growth of seed industry.

Unit 6:

Systematics of Vegetable Crops Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops; origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various vegetables; morphological keys to identify important families, floral biology, floral formula and diagram; morphological description of all parts of vegetables; cytological level of various vegetable crops; descriptive keys for important vegetables; importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

Unit 7:

Production of Underutilized Vegetable Crops Introduction, importance and scope of underutilized vegetable crops, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, nursery techniques viz. (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: Asparagus, artichoke and leek, Chinese cabbage, kale and artichoke, celery, parsley, parsnip, lettuce, rhubarb, bathu/chenopods, chekurmanis, elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and scarlet runner bean, sword bean, sweet gourd(Kakrol), spine gourd (Kartoli), pointed gourd, Oriental pickling melon, little gourd (kundru), Taro, Tannia, and Chinese potato.

Unit 8:

Post Harvest Management of Vegetable Crops Importance and scope of post-harvest management of vegetables; maturity indices and standards for different vegetables; methods of maturity determinations; biochemistry of maturity and ripening, enzymatic and textural changes, ethylene evolution and ethylene management, respiration, transpiration, Harvesting tools, harvesting practices for specific market requirements; post-harvest physiological and biochemical changes, storage disorders - chilling and freezing injury in vegetables, influence of pre- harvest practices and other factors affecting post-harvest losses, packaging house operations, pre-cooling- methods of precooling commodity pretreatments chemicals, wax coating, prepackaging and irradiation; packaging of vegetables, post-harvest diseases and prevention from infestation, principles of transport; Methods and practices of storage ventilated, refrigerated, MA & CA storage, hypobaric storage and cold storage, zero energy cool chamber; storage disorders.

Unit 9:

Organic Vegetable Production Importance, principles, perspective, concepts and components of organic farming in vegetable crops. Organic production of vegetable crops viz., Solanaceous, Cucurbitaceous, Cole, root and tuber crops. Managing soil fertility, mulching, raising green manure crops, weed management; crop rotation and crop diversification in organic production; quality control of organic vegetable produce. Indigenous methods of composting, Bioformulations, Panchyagavvya, Biodynamics preparations and their application; ITKs in organic vegetable farming; concentrated organic manures, crop residues, agro industrial wastes; Role of botanicals and bio-control agents in the management of pests and diseases in vegetable crops. Techniques of natural vegetable farming, GAP and GMP certification of organic products; organic vegetable seed production; processing, export opportunity and challenges in organic vegetable production.

Unit 10:

Protected Cultivation of Vegetable Crops Concept, scope and importance of protected cultivation of vegetable crops; Principles, design, orientation of structure, low and high-cost polyhouses/greenhouse structures. Classification and types of protected structures: greenhouse/polyhouses, plastic-non plastic low tunnels, plastic walkin tunnels, high roof tunnels with ventilation, insect proof net houses, shade net houses, rain shelters, naturally ventillated polyhouse, climate control greenhouses, vertical farming, hydroponics and aeroponics; soil and soilless media for bed preparation; design and installation of drip irrigation and fertigation system, use of IoT and digital technologies, Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity on growth and yield of different vegetables under protected cultivation. Climate control and automation. High tech vegetable nursery raising; Nursery problems and their management. Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber, cabbage, cauliflower, broccoli and off-season leafy vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures. 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.

Unit 11:

Processing of Vegetable Crops Present status and prospects of vegetable preservation industry in India. 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. Raw material for processing; Primary and minimal processing; processing equipment; Layout and establishment of processing industry; FPO license; Importance of hygiene; Plant sanitation. Quality assurance and quality control, Food standards FPO, PFA, etc.; Food laws and regulations; Food safety- Hazard analysis and critical control points (HACCP), Labeling and labeling act and nutrition labeling. Major value added vegetable products; Dehydration- methods, canning, pickling- spoilage of pickles; 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.


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