SYLLABUS FOR THE POST OF ASSISTANT HORTICULTURE OFFICER

(QUALIFICATION: Graduation in Horticulture from the University Established by law in India & accredited by ICAR)

FRUIT SCIENCE

Fundamentals of Horticulture: Scope, importance and economic significance of horticulture; classification, distribution, nutritional importance, area, production, productivity, export and import of fruit crops; horticultural regions of India and Karnataka; principles of orchard establishment, planning, layout and management; nursery techniques and quality planting material production; soil and climatic requirements; planting systems, planting densities, high-density and ultra-high-density planting; canopy architecture and orchard floor management; irrigation, fertigation, nutrient management, integrated nutrient management, weed management, mulching and soil health management; principles and methods of training and pruning; bearing habits of fruit crops, flowering, fruit set and factors influencing fruitfulness and unfruitfulness; crop regulation, rejuvenation of senile orchards, top working, frame working, use of plant growth regulators, precision horticulture, protected cultivation, mechanization, climate-resilient fruit production and sustainable orchard management.

Plant Propagation and Nursery Management: Principles of sexual and asexual propagation; seed biology, dormancy, germination and seed treatments; apomixis, polyembryony, monoembryony, chimeras and bud sports; propagation through cuttings, layering, grafting, budding, division, runners, suckers, offsets, stolons, corms and specialized vegetative structures; physiological, anatomical and biochemical basis of rooting and graft union formation; stock–scion relationships and graft incompatibility; propagation structures including mist chambers, greenhouses, polyhouses, glasshouses, hot beds, cold frames and phytotrons; nursery establishment, management, certification and accreditation; mother block establishment, budwood certification and maintenance; micrografting, micropropagation and tissue culture applications; nursery tools, implements and mechanization; role of plant growth regulators in propagation; production and maintenance of quality planting materials.

Production Technology of Tropical and Subtropical Fruit Crops: Origin, distribution, taxonomy, classification, varieties and rootstocks; climatic and soil requirements; propagation, planting systems and orchard management; canopy management, flowering and fruiting behaviour, crop regulation, irrigation, fertigation, nutrient and weed management; use of plant growth regulators; physiological disorders and their management; integrated production technologies; harvesting, maturity indices, post-harvest handling, grading, packaging, storage, transportation, value addition and export requirements of mango, banana, citrus, grape, guava, papaya, sapota, pineapple, pomegranate, jackfruit, avocado, litchi, mangosteen, passion fruit, rambutan, durian, carambola, bilimbi, loquat, breadfruit, rose apple and other important tropical and subtropical fruits. Special production problems including alternate and irregular bearing in mango and citrus, citrus decline, bud forecasting in grapes, seediness and Konkan disease of banana, sex expression and seed production in papaya, latex extraction and papain production and economics of commercial fruit production.

Production Technology of Temperate and Dryland Fruit Crops: Origin, distribution, classification, varieties, rootstocks, climatic adaptation, chilling requirements, propagation, planting systems, training and pruning, pollination, pollinizers and self-incompatibility, canopy management, irrigation, nutrient management, physiological disorders, harvesting and post-harvest management of apple, pear, peach, plum, apricot, cherry, strawberry, kiwi, persimmon, almond, walnut, pecan, hazelnut, chestnut and macadamia. Principles and practices of dryland horticulture including agro-climatic characterization of arid and semi-arid regions, watershed management, rainwater harvesting, soil and water conservation, moisture conservation, runoff management, micro-irrigation, antitranspirants, mulching, shelterbelts, drought management, climate-resilient production technologies, canopy management and special production techniques for ber, aonla, bael, custard apple, jamun, wood apple, pomegranate, carissa, date palm, tamarind, fig, phalsa, West Indian cherry and other arid fruit crops; management of replant problems, premature leaf fall, alternate bearing and other physiological constraints.

Protected Cultivation and Precision Horticulture: Precision technologies for protected cultivation, fertigation management, environmental control systems and smart greenhouses. IoT devices; environmental, soil and plant sensors; weather stations; automation in irrigation and fertigation; robotics; autonomous farm machinery; decision support systems. Global Positioning System (GPS), Geographic Information System (GIS), Remote Sensing (RS), drone technologies, field mapping and spatial data analysis.

Fruit Crop Improvement and Biotechnology: Scope and objectives of fruit breeding; origin, evolution, centres of diversity and domestication of fruit crops; germplasm exploration, characterization, evaluation, conservation and utilization; breeding behaviour, floral biology, pollination mechanisms, incompatibility systems and reproductive biology; introduction, selection, hybridization, mutation breeding, polyploidy, clonal selection, rootstock breeding and exploitation of naturally occurring variants including bud sports and chimeras; breeding strategies for yield, quality, shelf life and resistance to biotic and abiotic stresses; molecular breeding, marker-assisted selection, genomic selection, genome editing, transgenic approaches, tissue culture, embryo rescue and somatic hybridization; DUS testing, varietal protection, intellectual property rights and recent advances in fruit crop improvement.

VEGETABLE SCIENCE

Fundamentals of Vegetable Science: Scope, importance and economic significance of vegetable crops; classification, origin, centres of diversity, distribution, nutritional importance, area, production, productivity, export potential and value chain of vegetable crops; agro-climatic requirements; principles of vegetable production; cropping systems, crop rotation and intensive vegetable production; nursery management, protected nursery production and quality seedling production; field preparation, planting methods, spacing and crop establishment; irrigation, fertigation, integrated nutrient management, weed management, mulching, canopy management and use of plant growth regulators; physiological disorders and their management; precision vegetable cultivation, protected cultivation, organic and natural farming, climate-resilient vegetable production, mechanization and digital technologies in vegetable cultivation.

Production Technology of Tropical and Subtropical Vegetables: Origin, distribution, taxonomy, varieties and hybrids; climatic and soil requirements; nursery management, propagation, planting systems, crop establishment, irrigation, fertigation, nutrient management, weed management, crop regulation, use of plant growth regulators, physiological disorders, integrated production technologies, harvesting, maturity indices, post-harvest handling, grading, packaging, storage, transportation, value addition, processing, quality standards, export requirements and economics of cultivation of tomato, brinjal, chilli, sweet pepper, okra, cluster bean, cowpea, dolichos bean, French bean, cucumber, muskmelon, watermelon, bottle gourd, ridge gourd, sponge gourd, bitter gourd, snake gourd, ash gourd, pumpkin, squash, drumstick, sweet corn, curry leaf, amaranthus, basella, spinach beet, methi, dill, portulaca and other tropical and subtropical vegetable crops.

Production Technology of Temperate, Bulb, Root, Tuber and Perennial Vegetables: Origin, distribution, varieties and hybrids, climatic adaptation, nursery management, crop establishment, production technologies, irrigation, fertigation, nutrient management, crop regulation, physiological disorders, harvesting, post-harvest management and economics of cultivation of cabbage, cauliflower, broccoli, Brussels sprouts, knol-khol, Chinese cabbage, lettuce, spinach, onion, garlic, leek, radish, carrot, beetroot, turnip, peas, broad bean, celery, asparagus, globe artichoke, rhubarb, potato, sweet potato, cassava (tapioca), elephant foot yam, colocasia, dioscorea, arrowroot, horseradish, Jerusalem artichoke, xanthosoma and other important root, tuber, bulb and temperate vegetable crops.

Vegetable Crop Improvement and Seed Production: Scope and objectives of vegetable breeding; origin and evolution of vegetable crops; germplasm exploration, characterization, evaluation, conservation and utilization; reproductive biology, pollination mechanisms and breeding systems; genetics of qualitative and quantitative traits; breeding methods for self- and cross-pollinated vegetables; heterosis breeding, hybrid seed production, mutation breeding, polyploidy breeding and breeding for quality, yield and resistance to biotic and abiotic stresses; molecular breeding, marker-assisted selection, genomic selection, genome editing and transgenic approaches; maintenance breeding; breeder, foundation and certified seed production; seed certification standards, isolation distance, rouging, field and seed standards, seed processing, storage, testing and quality assurance for major vegetable crops including tomato, chilli, sweet pepper, brinjal, okra, peas, dolichos bean, French bean, cowpea, cucumber, muskmelon, watermelon, bitter gourd, ridge gourd, pumpkin, squash, cabbage, cauliflower, onion, radish, carrot, amaranthus and other commercially important vegetables.

Protected Cultivation and Precision Horticulture: Precision technologies for protected cultivation, hydroponics, aeroponics, vertical farming, fertigation management, environmental control systems and smart greenhouses. IoT devices; environmental, soil and plant sensors; weather stations; automation in irrigation and fertigation; robotics; autonomous farm machinery; decision support systems. Global Positioning System (GPS), Geographic Information System (GIS), Remote Sensing (RS), satellite imagery, drone technologies, digital elevation models, field mapping and spatial data analysis.

Protected Cultivation, Post-Harvest Management and Sustainable Vegetable Production: Principles and technologies of protected cultivation including polyhouses, net houses, shade-net structures, low tunnels and hydroponics; nursery raising under protected conditions; precision irrigation and

fertigation; integrated crop management; post-harvest physiology, maturity indices, harvesting techniques, grading, packaging, storage, cold chain management, processing, value addition, quality standards, food safety, traceability and export requirements; integrated management of physiological disorders, pests, diseases and nematodes; organic and natural vegetable production; Good Agricultural Practices (GAP), climate-smart vegetable production systems, resource-use efficiency and sustainable vegetable production technologies.

FLORICULTURE AND LANDSCAPE ARCHITECTURE

Fundamentals of Floriculture: Scope, importance and economic significance of floriculture and ornamental horticulture; history and development of floriculture in India and the world; classification, origin, distribution, nutritional, aesthetic and commercial importance of ornamental plants; garden styles including English, Japanese, Mughal, Italian, French and contemporary gardens; principles and elements of garden design; ornamental plant groups including annuals, biennials, perennials, bulbs, shrubs, trees, climbers, creepers, palms, cycads, ferns, orchids, cacti, succulents, indoor plants, foliage plants and aquatic ornamentals; lawn establishment and management; bonsai, topiary, floral art, flower arrangement including Ikebana, dry flowers and floral decorations; emerging trends in ornamental horticulture, urban greening, environmental landscaping and sustainable floriculture.

Production Technology of Commercial Flower Crops: Origin, distribution, varieties and hybrids, climatic and soil requirements, propagation, nursery management, planting systems, crop establishment, irrigation, fertigation, nutrient management, canopy management, use of plant growth regulators, physiological disorders, integrated crop management, protected cultivation, harvesting, post-harvest handling, grading, packaging, storage, value addition, quality standards, export requirements and economics of cultivation of rose, chrysanthemum, carnation, gerbera, gladiolus, tuberose, orchids, anthurium, lilies, jasmine, crossandra, marigold, China aster, dahlia, gaillardia, heliconia, bird of paradise and other commercially important cut flowers, loose flowers and ornamental crops; extraction of essential oils from aromatic flower crops including rose, jasmine and tuberose.

Protected Floriculture and Precision Production Technologies: Principles and practices of greenhouse, polyhouse, shade-net house and other protected cultivation systems for ornamental crops; environmental control, microclimate management, irrigation, fertigation, automation, hydroponics and precision nutrient management; integrated management of pests, diseases, nematodes and physiological disorders; climate-smart floriculture; production scheduling for domestic and export markets; post-harvest quality management, cold chain, packaging, transportation and marketing of cut flowers; economic feasibility, project formulation and enterprise management of protected floriculture. Precision technologies for protected cultivation, hydroponics, aeroponics, vertical farming, fertigation management, environmental control systems and smart greenhouses. IoT devices; environmental, soil and plant sensors; weather stations; automation in irrigation and fertigation; robotics; autonomous farm machinery; decision support systems.

Landscape Architecture and Environmental Planning: Scope, principles and elements of landscape architecture; functional, aesthetic and ecological uses of landscape plants; preparation of landscape plans and garden designs; computer-aided landscape design using AutoCAD, ArchiCAD, GIS and other digital tools; bio-aesthetic planning; urban landscaping and green infrastructure; landscape

development for residential areas, institutional campuses, public parks, hospitals, industries, highways, avenues, airports, railway stations, tourism centres, historical monuments, religious places, waterfronts, cemeteries and recreational parks; special gardens including rock, water, bog, marsh, sunken, terrace, roof, vertical, xeriscape, butterfly, fragrance, herbal, sensory, Japanese, Mughal, indoor and theme gardens; environmental landscaping for pollution mitigation, carbon sequestration, biodiversity conservation and climate resilience.

Ornamental Plant Improvement and Seed Technology: Scope and objectives of ornamental plant breeding; origin, evolution and genetic resources of ornamental crops; germplasm collection, characterization, evaluation, conservation and utilization; reproductive biology, floral biology, pollination mechanisms and breeding systems; selection, hybridization, mutation breeding, polyploidy breeding, heterosis breeding and exploitation of male sterility; breeding for novel flower colour, form, fragrance, flowering behaviour, vase life and resistance to biotic and abiotic stresses; molecular breeding, marker-assisted selection, tissue culture, micropropagation, doubled haploids, genome editing and transgenic approaches in ornamentals; breeder, foundation and certified seed production; seed certification standards, harvesting, processing, storage, testing and quality assurance for major flower crops including rose, carnation, gerbera, orchids, chrysanthemum, tuberose, gladiolus, petunia, zinnia, dahlia, hibiscus, bougainvillea and other ornamental species.

PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS

Plantation Crops: Principles and practices of production, propagation, nursery management, varietal improvement, planting systems, canopy management, nutrition, irrigation, weed management, cropping systems, intercropping, soil and moisture conservation, harvesting, post-harvest management, processing, quality standards, value addition, economics and marketing of plantation crops including **coconut, arecanut, cashew, coffee, tea, cocoa, rubber, palmyrah and betel vine**. Major physiological disorders, climate resilience, mechanization, precision production technologies and sustainable plantation management.

Spice Crops: Origin, distribution, economic importance, varieties and hybrids, propagation, nursery management, production technologies, integrated nutrient, water and canopy management, protected cultivation where applicable, physiological disorders, harvesting, curing, processing, grading, quality standards, value addition, storage, export requirements and economics of cultivation of **black pepper, small and large cardamom, turmeric, chilli, ginger, garlic, coriander, fenugreek, cumin, fennel, ajwain, vanilla, nutmeg, clove, cinnamon, allspice, tamarind and garcinia**. Production constraints, organic cultivation, Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), geographical indications (GI), traceability and spice export quality standards.

Medicinal Crops: Scope, importance, biodiversity conservation, cultivation, collection and sustainable utilization of medicinal plants. Production technologies, propagation, nursery management, crop improvement, agronomic practices, harvesting, post-harvest handling, drying, processing, quality standards, active principles, value addition, marketing and regulatory aspects (AYUSH, Good Agricultural and Collection Practices) of senna, periwinkle, medicinal coleus, ashwagandha, glory lily, sarpagandha, Aloe vera, amla, kalmegh, isabgol, opium poppy, safed musli, stevia, Mucuna, long pepper, Shatavari, guggul, cinchona, Dioscorea, steroid-bearing Solanum, chakramuni, madhunashini,

sweet flag, foxglove, belladonna, Tinospora, annatto, noni and other important medicinal crops of Karnataka.

Aromatic Crops: Importance, classification, propagation, cultivation practices, harvesting, post-harvest management, extraction of essential oils, quality evaluation, storage, value addition, industrial applications and economics of cultivation of palmarosa, lemongrass, citronella, vetiver, Mentha species, patchouli, geranium, Artemisia (davana), lavender, Ocimum species, sandalwood, rosemary, jasmine, rose, tuberose and chamomile. Essential oil chemistry, distillation techniques, quality parameters, utilization in pharmaceutical, cosmetic, perfumery and food industries.

Breeding and Genetic Improvement: Germplasm conservation, centres of origin, floral biology, pollination mechanisms, breeding objectives, conventional and molecular breeding approaches, hybridization, mutation breeding, polyploidy, biotechnology-assisted improvement, selection of superior cultivars, development of varieties resistant to biotic and abiotic stresses, quality improvement and breeding for export-oriented traits in plantation, spice, medicinal and aromatic crops.

Propagation and Nursery Management: Sexual and vegetative propagation methods, nursery establishment and management, grafting, budding, layering, cutting, tissue culture and micropropagation, production of quality planting materials, certification standards, nursery accreditation and entrepreneurship in nursery production.

Post-Harvest Management and Value Addition: Harvest maturity indices, harvesting methods, curing, drying, grading, packaging, storage, transportation, processing technologies, extraction of oils and phytochemicals, quality assurance, value addition, branding, geographical indications, export standards, traceability, cold-chain management and marketing systems.

Protected Cultivation and Precision Production: Application of protected cultivation, fertigation, precision irrigation, automation, sensors, digital agriculture, climate-smart technologies, mechanization and resource-use efficiency in high-value medicinal, aromatic and spice crops.

Production Economics and Agribusiness: Cost of cultivation, project preparation, entrepreneurship, contract farming, Farmer Producer Organizations (FPOs), processing enterprises, domestic and export marketing, commodity value chains, quality certification, organic production systems and sustainability in plantation, spice, medicinal and aromatic crop production.

POST-HARVEST TECHNOLOGY

Fundamentals of Post-Harvest Technology: Importance, scope and economic significance of post-harvest management in horticultural crops; post-harvest losses, causes and strategies for loss reduction; quality concepts and quality attributes of fresh horticultural produce; pre-harvest factors influencing post-harvest quality; maturity indices, harvesting standards and harvesting methods; physiological and biochemical changes during ripening and senescence; ethylene biosynthesis and action; climacteric and non-climacteric fruits; ripening regulation, delay and acceleration techniques.

Post-Harvest Handling, Packaging and Storage: Harvesting, field handling, cleaning, washing, curing, trimming, grading, sorting and standardization; pre-cooling methods; packaging materials, package design, cushioning materials, modified atmosphere packaging (MAP), controlled atmosphere packaging (CAP), active and intelligent packaging, edible coatings and biodegradable packaging; cold chain management; transportation systems; storage principles and methods including ambient, evaporative, refrigerated, controlled atmosphere (CA), modified atmosphere (MA), hypobaric and zero-energy cool chambers; physiological disorders and storage diseases; quarantine treatments and export protocols.

Processing of Fruits, Vegetables, Plantation and Spice Crops: Principles and objectives of food preservation; unit operations in food processing; thermal processing, pasteurization, sterilization, blanching and aseptic processing; preservation by sugar, salt, acids, fermentation, freezing, dehydration, irradiation and chemical preservatives; drying and dehydration technologies; minimal processing and fresh-cut produce; value addition and processing of fruits, vegetables, spices, plantation crops and medicinal plants; beverage technology; processing of jams, jellies, marmalades, squashes, juices, RTS beverages, pickles, chutneys, sauces, ketchup, dehydrated products, frozen products and spice products; curing and processing of spices, tea, coffee, cocoa and plantation products.

Food Chemistry, Quality Assurance and Food Safety: Composition and nutritional quality of horticultural produce; food additives and preservatives; food spoilage, microorganisms associated with processed products and methods of spoilage prevention; quality evaluation of fresh and processed products; sensory evaluation; food standards, grading and certification; HACCP, GMP, GHP, ISO systems; FSSAI regulations, AGMARK, BIS standards, Codex Alimentarius and export quality standards; residue limits, traceability and food safety management systems.

Post-Harvest Engineering and Value Chain Management: Post-harvest equipment and machinery for cleaning, grading, sorting, packaging, drying, pulping and processing; refrigeration and cold storage engineering; pack houses and ripening chambers; supply chain and cold chain logistics; marketing, export and international trade of fresh and processed horticultural produce; entrepreneurship, project formulation, techno-economic feasibility, establishment and management of post-harvest and processing industries; government policies, schemes and support systems for post-harvest infrastructure and value addition; biofortification and nutraceuticals.

CROP IMPROVEMENT

Plant Breeding and Crop Improvement: History and development of plant breeding in India; principles, objectives, scope and limitations of plant breeding; modes of reproduction in crop plants including self-pollination, cross-pollination, vegetative reproduction and apomixis; pollination mechanisms, self-incompatibility and male sterility systems; centres of origin and diversity of crop plants; plant genetic resources, germplasm conservation and utilization; breeding methods for self-, cross- and clonally propagated crops; selection methods, hybridization, pedigree, bulk and backcross breeding; heterosis, inbreeding depression, combining ability, development and evaluation of inbred lines and hybrids; quantitative genetics and biometrical approaches; mutation breeding, polyploidy breeding and special breeding techniques; breeding for resistance to biotic and abiotic stresses;

participatory plant breeding; plant variety protection, intellectual property rights (IPR), plant breeders' rights, farmers' rights and community rights.

Plant Physiology, Biochemistry and Genetics: Structure and function of plant cells; biomolecules including carbohydrates, lipids, proteins, nucleic acids and enzymes; plant pigments and secondary metabolites; metabolism and bioenergetics; water relations, mineral nutrition and biological nitrogen fixation; photosynthesis, respiration, photorespiration and C3, C4 and CAM pathways; plant growth and development; plant growth regulators and their applications; flowering, photoperiodism, vernalization, pruning and training physiology; physiology of seed development, dormancy and germination; fruit growth, development, ripening and post-harvest physiology; cell division, gametogenesis and fertilization; principles of inheritance, Mendelian and non-Mendelian genetics; mutation, chromosome behaviour, gene interaction, linkage and recombination; molecular basis of heredity, DNA replication, transcription, translation, central dogma and regulation of gene expression.

Seed Science and Technology: Seed development, maturation and physiology; seed structure, composition and quality; seed versus grain; history and development of the seed industry in India; seed systems, seed policies and national seed programmes; classes and generation system of seed multiplication; principles and methods of seed production in self-pollinated, cross-pollinated and hybrid horticultural crops; isolation requirements, rouging and maintenance of genetic purity; harvesting, drying, processing, grading, treatment and packaging of seeds; seed storage, seed deterioration and storage management; seed quality testing, germination, vigour and viability assessment; seed certification procedures, field inspection, field and seed standards, seed legislation, Seed Act, Seed Rules, Seed Control Order and seed certification agencies; seed enhancement technologies including priming, coating, pelleting and polymer treatment; seed marketing, quality assurance, duties and responsibilities of seed inspectors and seed analysts.

CROP PROTECTION

Diseases of Fruit, Plantation, Medicinal and Aromatic Crops: Etiology, symptoms, disease cycle, epidemiology, diagnosis and integrated management of diseases affecting mango, banana, citrus, grape, guava, sapota, papaya, pineapple, jackfruit, pomegranate, ber, aonla, fig, custard apple, apple, pear, peach, plum, strawberry and other fruit crops; diseases of plantation crops including coconut, arecanut, cocoa, coffee, tea, cashew, rubber, oil palm and betel vine; diseases of medicinal and aromatic crops including senna, neem, hemp, costus, datura, dioscorea, mint, opium poppy, patchouli, citronella, davana, Ocimum, sandalwood, Solanum viarum and other economically important medicinal and aromatic plants; post-harvest diseases of fruits, plantation, medicinal and aromatic crops and their integrated management.

Diseases of Vegetable, Spice and Ornamental Crops: Etiology, symptoms, disease cycle, epidemiology, diagnosis and integrated management of diseases of tomato, brinjal, chilli, okra, cabbage, cauliflower, knol-khol, radish, carrot, beetroot, onion, garlic, potato, sweet potato, peas, beans, cucurbits, fenugreek and other vegetable crops; diseases of spice crops including black pepper, ginger, turmeric, coriander, cumin, cardamom, nutmeg, clove, cinnamon, vanilla and other spice crops; diseases of ornamental crops including rose, jasmine, chrysanthemum, marigold, crossandra, tuberose, gerbera, anthurium, carnation, gladiolus, geranium and protected floriculture crops; post-harvest diseases of vegetables, spices and ornamental crops and their integrated management.

Insect Pest Management and Insecticides: Economic classification of insects; definition and types of pests; nature and extent of crop losses caused by insect pests; pest population dynamics and outbreak factors; economic threshold level (ETL) and economic injury level (EIL); pest surveillance, monitoring and forecasting; principles and components of Integrated Pest Management (IPM); cultural, mechanical, physical, biological, behavioural, legislative and chemical methods of pest management; biological control using predators, parasitoids, entomopathogens and weed biocontrol agents; mass production and field utilization of biological control agents; classification, formulation, mode of action, application, compatibility, resistance management and safe handling of insecticides; pesticide residues, maximum residue limits (MRLs), pre-harvest interval (PHI) and environmental safety.

Entomology of Vegetable, Spice and Protected Crops: Identification, distribution, host range, biology, seasonal incidence, nature of damage and integrated management of insect and mite pests of vegetable and spice crops including solanaceous, cucurbitaceous, cruciferous, leguminous, root and tuber vegetables, leafy vegetables and major spice crops; pest surveillance and forecasting; insect pests of protected cultivation and nursery crops; storage pests and processed-product pests of vegetables and spices; residue management, MRLs and export quality standards.

Entomology of Fruit, Plantation, Medicinal and Aromatic Crops: Identification, distribution, host range, biology, seasonal incidence, nature of damage and integrated management of insect and mite pests of tropical, subtropical and temperate fruit crops including mango, banana, citrus, grape, guava, papaya, pomegranate, sapota, apple and other fruit crops; insect pests of plantation crops including coconut, arecanut, cocoa, coffee, tea, cashew, rubber and oil palm; insect pests of medicinal and aromatic crops; pest surveillance and forecasting; storage pests of fruits, plantation, medicinal and aromatic produce and processed products; insecticide residue management, MRLs, PHI and safe pest management practices for domestic and export markets.

SOIL SCIENCE

Soil Physics, Chemistry and Soil Fertility: Physical properties of soils including texture, structure, bulk density, porosity, aggregation, consistency and soil-water relationships; soil colloids, cation and anion exchange, soil reaction (pH), electrical conductivity (EC), salinity, sodicity and calcareousness; soil organic matter, humus formation and C:N ratio; essential plant nutrients, their functions, deficiency symptoms, transformations and availability in soils; nutrient dynamics of nitrogen, phosphorus, potassium, sulphur, calcium, magnesium and micronutrients; soil fertility and productivity; integrated nutrient management (INM); soil health and soil quality concepts.

Problem Soils and Soil Resource Management: Characteristics, classification and management of acid soils, saline soils, sodic soils, saline-sodic soils, calcareous soils, waterlogged soils and degraded soils; irrigation water quality including pH, EC, SAR and RSC; management of poor-quality irrigation water; soil amendments including lime, gypsum and organic amendments; sustainable soil management for horticultural crops under diverse agro-climatic conditions.

Soil, Plant and Water Analysis: Principles and methods of soil, plant and irrigation water sampling; laboratory analytical techniques for estimation of soil pH, EC, organic carbon, available nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients (Fe, Zn, Cu, Mn and B); plant tissue analysis; irrigation water quality analysis; working principles, operation and applications of pH

meter, conductivity meter, spectrophotometer, flame photometer, atomic absorption spectrophotometer (AAS), ICP and other analytical instruments; interpretation of analytical results for nutrient recommendations.

Fertilizers, Organic Manures and Agricultural Chemistry: Classification, properties, manufacture and quality standards of fertilizers including straight, complex, mixed, secondary and micronutrient fertilizers; characteristics and use of major fertilizers such as urea, DAP, SSP, MOP, SOP and water-soluble fertilizers; methods and timing of fertilizer application; fertilizer-use efficiency; Fertilizer Control Order (FCO); organic manures including FYM, compost, vermicompost, green manures and enriched organics; biofertilizers including *Rhizobium*, *Azotobacter*, *Azospirillum*, phosphate-solubilizing microorganisms and mycorrhizae; integrated nutrient management, site-specific nutrient management and precision nutrient management.

Microbial Transformations and Nutrient Cycling: Role of microorganisms in carbon, nitrogen, phosphorus and sulphur cycles; decomposition of organic matter and humus formation; biological nitrogen fixation including symbiotic, associative and free-living systems; ammonification, nitrification and denitrification; phosphorus mineralization and solubilization; mechanisms of phosphate solubilization; mycorrhizae including ectomycorrhizae and endomycorrhizae, their biology, ecology and role in nutrient mobilization and plant growth promotion; microbial transformations of essential nutrients and their significance in soil fertility.

Agricultural Microbiology and Bio-inputs: Biofertilizers including *Rhizobium*, *Azotobacter*, *Azospirillum*, phosphate-solubilizing microorganisms, potassium-solubilizing microorganisms, cyanobacteria and mycorrhizae; production technology, quality standards and field application of biofertilizers; biopesticides based on bacteria, fungi, viruses and beneficial microorganisms; plant growth-promoting rhizobacteria (PGPR); microbial consortia; microbial inoculants for sustainable horticulture; role of microorganisms in composting, vermicomposting, waste recycling, biodegradation and bioremediation; microbial management of agricultural and horticultural wastes.

AGRICULTURAL ENGINEERING

Farm Power and Agricultural Machinery: Forms and sources of energy in agriculture; units and dimensions of force, work, energy and power; energy calculations and efficiency; internal combustion (IC) engines—principles of operation of spark ignition and compression ignition engines; two-stroke and four-stroke engines; engine components, terminology, performance and maintenance; tractors—classification, selection, power transmission systems, operation, maintenance and applications in horticulture; farm machinery management and economics.

Tillage, Planting and Intercultural Equipment: Objectives and principles of tillage; primary and secondary tillage operations; construction, working principles, adjustment, calibration, field capacity and maintenance of tillage implements including indigenous ploughs, improved ploughs, mouldboard ploughs, disc ploughs, rotary tillers, cultivators, harrows, levellers, ridgers and bund formers; sowing, planting and transplanting equipment including seed drills, precision planters, potato planters and vegetable transplanters; intercultural implements including hoes, weeders, sweep cultivators and power weeders; mechanization of horticultural crop production systems.

Soil and Water Engineering: Soil-water-plant relationships; irrigation methods including surface, sprinkler, drip and micro-irrigation systems; irrigation scheduling, water-use efficiency and fertigation; pumps, pipelines and irrigation accessories; rainwater harvesting, watershed management and groundwater recharge; soil and water conservation measures; land development and drainage systems; precision irrigation technologies for horticultural crops.

SOCIAL AND ALLIED SCIENCES

Agricultural Extension Education: Extension education systems in India; extension approaches and methodologies; technology assessment, refinement and transfer; ICAR extension programmes; Extension programme planning, implementation, monitoring and evaluation; communication process, models, barriers and feedback; extension teaching methods and audio-visual aids; information and communication technologies (ICT), digital agriculture, e-extension and mobile-based advisory services; diffusion and adoption of innovations; innovation-decision process; leadership development; group dynamics; human resource development; capacity building; management principles and functions; monitoring and evaluation; entrepreneurship development, agripreneurship, startup ecosystem, government policies, schemes and incentives for entrepreneurship promotion; extension reforms and public–private partnerships.

Computer Science and Information Technology: Fundamentals of computers; hardware and software; operating systems; input, output and storage devices; computer networks; internet, web technologies and cloud computing; MS Office applications; database management; cybersecurity basics; digital communication tools; applications of information technology in horticulture, agriculture, research, extension, precision farming, GIS, remote sensing and decision support systems; emerging technologies including artificial intelligence, machine learning, Internet of Things (IoT), drones and big data in agriculture.

Agricultural Economics and Agribusiness Management: Principles of micro and macroeconomics; consumer behaviour; demand, supply and price determination; elasticity of demand and supply; production economics and production functions; laws of returns; cost concepts, cost analysis and break-even analysis; farm management, farm planning and budgeting; agricultural finance, credit and financial institutions; project formulation and appraisal; investment analysis using BCR, NPV, IRR and payback period; agricultural marketing systems, market structure, marketing functions, channels and price spread; value chain and supply chain management; grading, standardization and quality assurance; SWOT analysis; agribusiness management; contract farming; Farmer Producer Organizations (FPOs); agricultural insurance and risk management; NABARD and other institutional support systems; WTO, international trade, export-import policies and agricultural marketing reforms.

DIRECTOR OF HORTICULTURE
And Chairman,
Competitive Examination Syllabus Committee