परीक्षा योजना एवं पाठ्यक्रम

Subject Matter Specialist/T-6, PB-3, 15600-39100(GP-5400) Level-10

MINIMUM ESSENTIAL QUALIFICATION

Concerned/Relevant disciplines	Minimum Essential Qualification
Subject Matter Specialist /T-6	
SMS, Horticulture	Master's degree in Horticulture or equivalent qualification from a recognized University with 4 years Bachelor degree in Agriculture/Horticulture.
SMS, Extension	Master's degree in Agriculture Extension or equivalent qualification from a recognized University.
SMS, Home Science	Master's degree in Home Science (Community Science) or equivalent qualification from a recognized University with 4 years Bachelor degree in Home Science.
SMS, Animal Husbandry	Master's degree in Animal Science/Animal Husbandry & Dairying or equivalent qualification from a recognized University with 4 years Bachelor degree in Agriculture/Animal Science/Animal Husbandry & Dairying.
SMS, Plant Protection	Master's degree in Plant Pathology / Entomology or equivalent qualification from a recognized University with 4 years Bachelor degree in B.Sc. (Ag.) Hon's
SMS, Agronomy	Master's degree in Agronomy or equivalent qualification from a recognized University with 4 years Bachelor degree in B.Sc. (Ag.) Hon's

क्रमांक	विषय	परीक्षा अवधि (घन्टे)	अधिकतम अंक
प्रश्न पत्र–1			
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Syllabus for Subject Matter Specialist

Horticulture

Floriculture and Landscaping

Unit-1: Production Technology for Loose Flowers

Scope and scenario: Scope scenario and importance of loose flowers nursery management, pro- tray nursery under shade nets, transplanting techniques; Soil analysis field preparation, systems of planting, Water and nutrient management, weed management, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM; Crop regulation: Flower forcing and year round flowering, chemical regulation Post harvest management and marketing: Harvest indices, harvesting techniques, post- harvest handling and grading, packing and storage, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agri Export Zones. Crops- Jasmine, scented rose, chrysanthemurn, marigold, China Aster. tuberose, crossandra, nerium, spider lily, hibiscus, barlerin, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, water lilies, tecoma, champaka, balsam).

Unit-2: Production Technology of Cut Flowers

Scope and scenario: National and International scenario, Importance and scope of cut flower trade, constraints for cut flower production in India. Growing environment, soil health and analysis, open cultivation, protected cultivation, Soil/media planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering; Crop management-water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, Flower regulation: Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation; Post harvest management and marketing. Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling. Pre-cooling, pulsing. packing. Storage & transportation, marketing, export potential, institutional support, crop insurance Agra Export Zones; Crops: Cut rose, cut chrysanthenum, carnation, gerbera, gladioli, tuberose, orchids, anthodium, aster, lilies, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophila, solidago, limonium, statice, stock, cut greens and fillers.

Unit-3: Protected Floriculture

Principles and types: Prospects of protected floriculture in India: Types of protected structures Greenhouses, polyhouses, shade houses, rain shelters ete. Principles and design: Principles and designing and erection of protected structures; Low cost/Medium cost/High cost structures economics of cultivation: Location specific designs, Structural components. Suitable flower crops for protected cultivation; Environment control Microclimate managerment and manipulation of temperature, light, humidity, air and CO2, Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light 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 and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation; Automation and standards: Sensors, solar greenhouses, GAP/flowerlabels, Export standards, EXIM policy. APEDA regulations for exports.

Unit-4: Value Addition in Floriculure

Scope and scenario: Scope and prospects of value addition, National and global scenario, productionand exports, Women empowerment through value added products making, supply chain management, Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, Morebana, freestyle, 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: Techniques in dry flower making - Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement - dry flower baskets, bouquets, potpourri, wall hangings, button holes, greeting cards, wreaths, Packing and storage; Extraction of value added products: essential oils; Selection of species and varieties (including non- conventional species), extraction methods, Packing and storage, Aromatherapy Pigments and nutraceuticals: Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments as nutraceuticals, Extraction methods; Applications in food, pharmaceuticals and poultry industries.

Unit-5: Nursery Management, Seed Production of Ornamental Plants and Specialty Flowers

Scenario of nursery industry, sexual and asexual propagation micro propagation and nursery management, sanitary and phytosanitary issues, nursery standards, etc. Seed production, in

Flower crops: Scenario of seed industry, scope and importance of seed production in flower crops seed production methods and improvements, seed regulations, Specialty flowers, fillers and cut greens: Importance, National and international scenario, Specialty flowers and cut greens cultivation, trade and marketing.

Unit-6: Ornamental Horticulture & Landscaping

Historical background of gardening. Importance and scope of ornamental gardening. Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams or Hindu type of gardon, Buddha garden; Garden components (living and non-living), arboretum, shrubbery, fernery, palmatum. arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves, Specialized gardens: vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, Zen garden; Principles and elements of landscaping: Basic drawing skills, garden symbols, steps in preparation of garden design Elements and principles of landscape design: visual aspects of plan, Landscaping for different situations: Urban landscaping. Landscaping for specific situations, institutions, industries, residents, hospital roadies traffic islands, damsites, IT/SEZ parks, corporate; Bio-aesthetic planning ecotourism theme parks, indoor gardening, therapeutic gardening, non-plant components.

Unit-7: Turf Grass Management

Prospects of landscape industry: History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment. Types of Turf grasses Types, species, varieties. hybrids, Selection of 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, synthetic turfing. Turf management Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in

turfs, Turf for different grounds: Establishment and maintenance of turfs for playgrounds, viz golf, football, hockey, cricket, tennis, rugby, residential and public parks, turfing for govt and corporate office gardens, turf colorants.

Fruit Science

Unit-1: Tropical and Subtropical Fruit Production

Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, National and International scenario, national problems, eco physiological requirements, global warming and climatic variability on fruit production in India and global level. Asexual and sexual methods of propagation, recent advances in propagation, root stocks, planting systems, High density planting, crop modeling, precision farming, decision support systems aspects of crop regulation- physical and chemical regulation, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of biofertilizers, role of bio-regulators, abiotic factors limiting fruit production. Stress effects on fruit physiology and development, influence of stress factors, strategies to overcome stress effects, Organic farming systems soil health managerment in organic production and quality improvement in organic production of fruit crops. The NPOP, HACCP, IFOAM guidelines for organic production and certification physiological and biochemical factors associated with absoor stress, fruit crops suitable for different stress situations Physiology of flowering, pollination management, fruit set and development, unfruitfulness, self- incompatibility and sterility. Physiological disorders - causes and remedies, crop regulation. quality improvement by management practices, maturity indices, harvesting, grading, packing. Transport, storage and ripening techniques, Agri-Export Zones (AEZ), marketing and industrial supports Crops. Mango, Banana, Citrus, Papaya, Grapes, Guava, Sapota, Jackfruit, Jamun, Litchi, Avocado, Rambutan, Durian, Mangosteen, Longan and Dragon fruit

Unit-2: Temperate Fruit Production

Importance of temperate fruits and nuts, origin and distribution, major species, rootstocks and commercial varieties of regional, National and International scenario, national problems. Global warming and climatic variability on fruit production in India and global level eco physiological requirements. Asexual and sexual methods of propagation, recent advances in propagation, root stocks, scion and inter stock relationship graft incompatibility, planting systems. High density planting, crop modeling, precision farming, decision support systems aspects of crop regulation- physical and chemical regulation, training and praning methods. rejuvenation, intercropping, nutriem mariagement, water management, fertigation, use of biofertilizers, role of bio-regulators, abiotic factors limiting fruit production, Stress effects on fruit physiology and development, influence of stress factors, strategies to overcome stress effects, Organic farming systems, soil healthmanagement in organic production and quality improvement in organic production of fruit crops. The NPOP, HACCP, IFOAM guidelines for organic production and certification. Stress effects on fruit physiology and development, influence of stress factors, strategies to overcome stress effecis Physiology of flowering. pollination management, fruit set and development, unfruitfulness, self-incompatibility and sterility, pests and disease management physiological disorders causes and remedies, crop regulation, quality improvement by management practices, maturity indices, harvesting grading, packing, storage and ripening techniques, Agri-Export Zones (AEZ), marketing. Industrial supports and measures for import substitution.

Crops: Apple, Pear, Peach, Plum, Apricot, Persimon, Cherries, Currents, Strawberry, Kiwi fruit, Walnut, Almond, Pistachionut, Hazelnut and Peccannut

Unit-3: Arid and Dry Land Fruit Production

Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, National and International scenario, national problems, eco physiological requirements. Characteristics features and major constraints of the arid and dryland region, distinguishing features of the fruit species trees for adaptation in adapting to the region, nutritional and pharmaceutical importance, national problems Asexual and sexual methods of propagation, recent advances in propagation, root stocks, planting systems, High density planting, crop modeling, precision farming, decision support systems aspects of crop regulation- physical and chemical regulation, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of biofertilizers, role of bio-regulators and abiotic factors limiting frat production. Stress effects on fruit physiology and development, influence of stress factors, strategies to overcome stress effects, Strategies o overcome stress effects, integrated and modern approaches in water and nutrient management Greenhouse effect and methane emission and its relevance to abiotic stresses, se of anti transparent and PGRs in stress management, mode of action and practical use, HSP mducers in stress management techniques of soil moisture conservation, mulching, hydrophilic Olymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, stability and sustainability indices. physiological disorders causes and remedies, crop regulation, quality improvement by management practices, maturity indices, harvesting, grading, packing, storage and ripening techniques, Agri-Export Zones (AEZ), marketing and industrial supports and and measures for import substitution.

Crops: Aonila, Ber, Bael, Custard apple, Datepalm, Fig, Karonda. Pomegranate, Phaisa, Wood apple.

Unit-4: Growth and Development

Growth and Development- definition, concepts and principles, parameters of growth and development, growth dynamics, morphogenesis, cco-physiological influences on growth and development of fruit crops-flowering, fruit set, crop load and assimilate partitioning and distribution. Environmental impact on growth and development effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat Units and thermoperiodism. Assimilate. partitioning, influence of water and mineral nutrition in growth and development, concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brasssinostcroids, other New PGRs. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, frait drop, fruit growth, ripening and seed development. Phytohormones and growth regulators, root and canopy regulation, study of plant growth regulators in fruit culture-structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phytohormones internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition canapy management for fertigated archuirds. Growth regulation aspects of propagation, embryogenesis, sood and bud dormancy, fruit bud initiation, segolation of flowering, off season production. Flower drop and thinning, fruit-set and developmem, fruit drop, panthemscarpy, fruit matunty and ripening and storage and molecular approaches in crop growth regulation

Unit-5: Canopy Management in Fruit Crops

Canopy management and its importance, factors affecting canopy development, canopy types and strictures with special emphasis on geometry of plasting, canopy manipulation for optimam utilization of light and its interception and distribution in different types of tree Canopies. Spacing and ceilization of land area - Canopy classification; Canopy managerment Batough rootstock and scion. Cacopy management through plant growth inhibitors, training and pruning and management practices. Rootstocks for management of tree vigine and trellising in fruit crops, Canopy development and managensent in relation to growth, flowering, fruiting and fruit quality.

Unit-6: Biodiversity and Conservation

Biodiversity and conservation, issues and gouls needs and challenges, centres of origin of crops, present status of gene centres, world's major centres of fruit crop domestication, current status of germplasm availability/database of fruit crops in India Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections. Development of fruit crop descriptors- based upon Bioversity International Descriptors and UPOV/DUS test guidelines, botanical and pomological description of major cultivars androotstocks of tropical, subtropical and temperate fruits and nut crops. Germplasm conservation in situ and ex situ strategies, on farm conservation. custodian farmers, field gene banks (FGB) and National Active Germplasım Sites (NAGs), problem of recalcitrancy- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage. Germplasni Exchange, Quarantine andIntellectual Property Rights Regulatory. inventory and exchange of fruit and nut germplasm, plant quarantine, phytosanitary certification, detection of genetic constitution of germplasm and maintenance of core zollection. IPRs, Breeder's rights, Farmer's rights, PPV&FR AcLGIS and documentation of local biodiversity, Geographical indications, GIS application inhorticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India.

Unit-7: Smart Fruit Production

Protected cultivation and precision farming techniques in fruit crops. 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 Introduction and importance, concepts and applications of artificial intelligence systems; case studies in horticulture. GIS, Sensors and Wirclcss Systems Application of sensors in frat production, crop monitoring-crop load and stress incidence forecast modules, remote sensing, Geographical information System (GIS), Differential Geo-Positioning System (DGPS) hi-tech nursery production of fruit crops under protected conditions, ultra-modern wireless based drip irrigation network. Nanotechnology for smart nutrient delivery in fruit farming, concepts and methods, practical utility, nano-fertilizers, nano-herbicides and nano-pesticides Mechanizatio, Automation and Robotics: Production systems amenable to automation and mechanization; automated protected structures (turn-key system); hydroponics, aeroponics, bioreactors for large scale plant multiplication; Use of drones and robotics in fruit growing-robotic planters, sprayers, shakers, harvesters, stackers etc.

Unit-8: Post Harvest Management

Maturity indices, harvesting practices for specific market requirements, influence of pre- harvest practices, enzymatic and textural changes, respiration and transpiration Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling. Treatments prior to shipment, viz., chlorination, waxing. chemicals, biocontrol agents and natural plant products. Methods of storage: ventilated. refrigerated, MAS, CA storage, physical injuries and disorders. Packing methods and transport principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies and candies. Dried and dehydrated products, outritionally enriched products, fermented fruit beverages, packaging technology, processing waste management. food safety standards. National and international fruit export and insportscenario and trends: Statistics and India's position and potentiality in world male, export promotion zones in India and Government Policies Scope, produce specifications quality and safely, standards for export of fruits viz., mango, banana, grape, stati, nomegale walnut apple another important fruts. Processed and value-added products, post harvest management for export including packaging and cool chain; HACCP, Codex alimentations, ISO certification: WTO and its implications, sanitary and phyto-sanitary measures.

Plantation, Spices, Medicinal and Aromatic Crops

Unit-1: Production of Plantation Crops

Role of plantation crops in national economy, export potential, scope and challenges, role of commodity boards and Directorates in developments of plantation crops- FPO, FPC, NGOs etc. Classification and varietal wealth, plant multiplication including in vitro multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, carbon sequestration potential of plantation crops, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning. Crop regulation, maturity indices, harvesting including, impact of bioticand abiotic factors. Pre and postharvest factors on quality and their management, quality standards- HACCP, BIS standards, grading. packaging and export standards. Cost benefit analysis, precision fanning, application of nano- technology. Postharvest handling including primary processing, value addition, grading, packaging, storage and benefit cost analysis.

Crops: Coconut, Arecanut, Oil palm, Palmyrah, Cashew, Cocoa, Coffee, Tea, Rubber and Betel vine. Underexploited crops- Wattle, minor species of Areca, Coffea, Hevea

Unit-2: Production of Spice Crops

Introduction, importance of spice crops-historical accent, present status national, and international, future prospects. Role of commodity boards and Directorates in developments of spices; botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping. mixed cropping, intercultural operations, weed control, mulching, physiological disorders, impact of biotic andabiotic factors, maturity standards, harvesting, Pre and postharvest factors on quality and their management, quality standards- HACCP, BIS standards, grading, packaging and export standards. Postharvest management, plant protection massures and seed planting material andmicro-propagation, pharmaceutical significance, precision farming, hydroponics, aeroponics and application of nano- technology Postharvest handling including prinsary processing, value addition, grading, packaging, storage and benefit cost analysis.

Crops: Black pepper, Small & Large cardamom, Clove, Cinnamon, Nutmeg, Allspice, Turmeric, Ginger, Garlic, Coriander, Fenugreek, Cumin, Fennel, Ajowan, Dill, Celery, Tamarind Garcinia and Vanilla.

Underexploited crops Mictum verum, Myristica malabarica: M. heddomei, Cinnamomum tamala, C. alabatrum, Xanthoxylum sp., Curcuma aromatica, C.caesia, C. zedoaria, C amada, Anethum graveolense. Hyssopus officinalis, Eringium foetidum. Pimpinella anirum, Artocarpus lacucha

Unit-3: Production of Medicinal and Aromatic Crops

Importance of medicinal and aromatic plants in human health, national economy and related industries, Role of institutions, Medicinal Plant Board and NGOs in promotion of MAP's, Domestication of MAPs, contract farming,, classification of medicinal and aromatic plants according to botanical characteristics and their uses export potential and indigenous technical knowledge. Climate and soil requirements, cultural practices, impact of biotic and abiotic factors on secondary metabolite production, maturity standards, harvesting, Pre and postharvest factors on quality and their management, quality standards, yield and important constituents of medicinal plants, precision farming,

protected cultivation, Quality standards in MAPs and in herbal products, phytochemicals and drug development, legislation on plant drugs, domestic and international standards, aroma therapy, Bioreactors, pharmacology and pharmacognosy, Postharvest handling including drying, primary processing, value addition, grading. packaging, storage and benefit cost analysis.

Crops:

Medicinal- Rauwolfia, Isabgol, Poppy, Aloe vera, Satavari, Stevia, Safed Musli, Kalmegh, Asafoetida, Nux vomica, Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Dioscorea, Digitalis, Medicnal solanum, Mucuna puriens, Piper longum, Plumbago zeylanica.

Aromatie- Citronella, Palmarosa, Vetiver, Mentha, Sweet flag, Lemon grass, Rose, Patchouli, Geranium, Jasmine, Artemisia, Ocimum sp., Eucalyptus, Sandal ha

Underexploited crops-

Medicinal crops- Flacourtia montana, Plectranthus aromaticus, Adhatoda sp. Hemidesmus Indicus. Tinospora cordifolia, Gymnema sylvestre, Psoralea corylifolia, Eclipta alba, Aristalochia indica, Morinda citrifolia. Caesalpinia sappan, Terminalia chebula, T. bellerica, Phyllanthus amarus. Strychnos nuxvomica,, S indicum, S. xanthocarpum, Aegle marmelos. Alpinia sp.. Hibiscus subdariffa, Anthocephalus kadamba, Costus sp., Kaempferia rotunda, K parviflora, Picrorrhiza kurroa, Nardostachis jatamansi, Valeriana officinalis, Swertia chiraita, Aconitumsp., Salvia officinalis, Centella asiatica. Biza orellana, Bacopa monnieri. Aromatic crops- Bursera sp., Commiphora wightii, Ocimum kilimandjaricum, Melaleuca, Michaelia champaka, Rosa damascena, Cananga odorata, marjoram, chamomile.

Unit-4: Organic Spice and Plantation Crops Production

Importance, principles, perspective, concept and components of organic production, status of organic farming at national and global level, organic production and export opportunities and challenges. Organic conversion plan-advanced methods for enhancing soil fertility and soil amendments. Managing soil fertility- mulching, raising green manure crops, crop rotation in organic horticulture, Indigenous methods of composting, panchagavya etc., pests, diseases and weed management in organic farming system, use of biofertilizers, botanicals and bioagents. Organic farming systems-Natural farining, permaculture, biodynamic farming, Zero-budget farming, Homa farming, EM technology. Certification and quality control- Accreditation and certification agencies. procedures and types of certification. Domestic and international standards- NPOP, IFOAM, CODEX, HACCP, PGS in quality control and quality control for organic products.

Crops: Coconut, Coffee, Cocoa, Tea, Areca nut, Black pepper, Cardamom, Turmeric, Ginger, Vanilla, Cumin, Coriander, Fennel, Fenugreek.

Unit-5: Growth and Development of Plantation, Spice, Medicinal and Aromatic Crops

Growth and development- definitions, components, photosynthetic productivity,

different stages of growth, growth curves, growth analysis, morphogenesis. Growth pattern and growth dimorphism in annual, semi-perennial and perennial crops, environmental impact effect of light, temperature, photoperiod on growth and development; Assimilate partitioning,influence of water and mineral nutrition; Canopy management for conventional and high density planting, pruning, training, chemicals, production. Basic functions, biosynthesis and role of plant bio regulators auxins, gibberellins, cytokinins, ethylene, inhibitors and retardants; Developmental physiology

and biochemistry during dormancy, bud break, juvenility. Physiology of flowering, what

ARS Examination Revised Eligibility and Syllabus photoperiodism, vernalization, effect of temperature, heat Units, thermoperiodism, pollination, fertilization, 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-6: Abiotic Stress Management in Plantation. Spice. Medicinal and Aromatic Crops

Definition: Stress due to soil conditions and salts salinity, alkalinity, ion toxicity, fertilizer toxicity, fertilizer toxicity symptoms, mechanisms governing tolerance, and salt stress. Stresses due to water (high and low) and temperature (high and low). Stress due to gaseous pollutants and heavy metals, Stress due to radiation, wind and nutrients. Symptoms, mechanisms governing tolerance, associated physiological and biochemical factors, impactof stress on PSMA crops and produce, changes in phenology and quality.. Climate change, factors contributing to climate change, change in temperature, rainfall, humidity, rise in the atmospheric CO_2 levels, tropospheric ozone levels, extreme climatic events. Global warming, carbon trading, role of green house gases, impact on productivity of PSMA crops. Clean development mechanism; Impact of climate change on Plantation, Spices, Medicinal and Aromatic crops; Climate resilient technologies, resistant varieties, Alternate farming systems, Zero waste management, Microbial waste management.

Unit-7: Marketing and Trade of Plantation, Spice, Medicinal and Aromatic Crops Market opport Unities and challenges at domestic and global level, requirements of raw material by domestic industry. Demand-supply scenario, marketing strategies and trade for raw and value added products. Direct and indirect marketing, niche marketing, speciality markets, market intermediaries and their role, market infrastructure needs, marketing efficiency, market organization, planning, promotion, cost control, contract farming

Marketing co-operatives including tribal co-operatives, publie private partnerships (PPP), Farmer Producer Companies (FPC) and Farmer Producer Organizations (FPOs). Supply chain and quality management-Transportation procedures, cold storage facilities, State trading, warehousing and other govt agencies. Role of Commodity boards and Export promotion councils in marketing and export of PSMA crops. Entrepreneurship development-Decision making: Risk taking, motivation, planning, monitoring, evaluation and follow up, SWOT analysis, generation, incubation and commercialization of ideas and innovations, Domestic and export market intelligence. export standards.

Role of information technology and telecommunication in marketing. Price analysis and priceforecasting, policies on export, import and re-export of commodities and value addedproducts, guidelines for marketing of organic produce and organic products

Vegetable Science

Unit-1: Production of Vegetable Crops

Introduction, commercial and nutritional importance, ares, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/hybrids, seed rate and seed treatment, raising of nursery, sowing/planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, Grafting techniques and its applications in different vegetable crops, weed control, role of plant growth regulators, harvesting, post harvest management, physiological disorders, post and disease management and production economies. Organic production of vegetables, Managing soil fertility, raising green manure crops, weed

management in organic farming system; Crop rotation in organic production; quality control of organic vegetable produce, Techniques of natural vegetable farming, GAP and GMP certification of organic products. Export opportunity and challenges.

Bulb crops: Onion, garlic, Cole crops Cahhage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale, Root crops: Carrot, radish, turnip and beetroot, Peas and beans-Garden peas, French bean and broad bean, Fruit vegetables, tomato, brinjal, hot pepper, sweet pepper and okra, Beans: Indian bean (Sem), cluster bean and cowpea, Cucurbitr: cucumber, melons, gourds, pumpkin and squashes, Tuber crops: potato, sweet potato, elephant foot yam, tapioca, taro and yam, Leafy vegetables: beet leaf, fenugreek, coriander, lemice. Amaranth, curry leaf and drumstick.

Unit-2: Production of Under Utilized Vegetable Crops

Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post harvest management of Stem and bulb crops. Asparagus, leek and chinese chive. Cole and salad crops. Red cabbage, chinese cabbage, kale, artichoke, sweet corn and babycorn, Gourds and melons: oriental pickling melon. Sweet gourd, spine gourd, teasle gourd, round gourd, and little/lvy gourd, snake gourd, pointed gourd, kachri, long melon, snap melon and gherkin, Leafy vegetables: Celery, parsley, parsnip, indian spinach (poi), spinach, chenopods, chekurmanıs, Rhubarb, Yam and beans. Elephant foot yam, yam, yam bean, lima bean, winged bean and jack bean, sword bean.

Unit-3: Growth and Development of Vegetable Crops

Definition of growth and development; Cellular structures and their functions, Physiology of phyto-hormones functioning/biosynthesis and mode of action; Growth analysis and its importance in vegetable production; Types and phystology of dormancy and germination of vegetable seeds, tubers and bulbs; Methods to overcome dormancy. Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops, Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production: Impact of light, temperature, vernalization, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops: Apical dominance; Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops: phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening; Morphogenesis and tissue culture techniques in vegetable crops.

Unit-4: Systematics of Vegetable Crops

Significance of systematics and crop diversity in vegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops, Origin, history, evolution and distribution of vegetable crops, Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram, Morphological description of all parts of vegetables, Cytological level of various vegetable crops with descriptive keys, Importanceof molecular markers in evolution of vegetable crops, Molecular markers as an aid in characterization and taxonomy of vegetable crops.

Unit-5: Biodiversity and Conservation of Vegetable Crops

Biodiversity and conservation, issues and goals-needs and challenges; present status of gene centres, world's major centres of vegetable crop domestication, current status of germplasm availability/database of vegetable crops in India Exploration and collection of germplasm; sampling frequencies; size and forms of vegetable germplasm collections; active and base collections. Germplasm conservation in situ and ex situ strategies, on farm conservation, problem of recalcitrance-tissue culture, cryopreservation, pollen and seed storage.

Germplasm exchange, and plant quarantine, phytosanitary certification, detection of genetie constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPVandFR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI taggedvegetable varieties in India.

Unit-6: 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, hydroponics and aeroponies; Soil and soilless media for bed preparation; Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables, High tech vegetable nursery raising in protected structures; regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber, melon, lettuce and broccoli 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: Economies of greenhouse crop production.

Unit-7: Seed Production and Certification of Vegetable Crops

Introduction, definition of seed and its quality, seed morphology, development and maturation; environmental factors on flowering and bolting. Apomixis and fertilization; Modes of propagation and reproductive behaviour: History of vegetable seed production: Status and share of vegetable seeds in seed industry, Agro-climate and its influence onquality seed production; Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production; Methods of seed production, hybrid seeds and techniques of large scale hybrid seed production; Seed village concept, Seed multiplication ratios and replacement rates in vegetables; Generation system of seed multiplication, Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds.

Improved agro- techniques; Field and seed standards in important solanaceous, leguminous, cucurbitaceous, cole crops, leafy vegetables, bulbous and root crops and okra, clonal propagation and multiplication in tuber crops-Potato, sweet potato, colocasia, tapioca, Seed plot technique and true potato seed production in potato, 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, factors affecting seed longevity in storage (Pre and post harvest factors), Principles of seedstorage; Orthodox and recalcitrant seeds; Seed aging and deterioration, maintenance of seed viability and vigor during storage, storage methods, storage structures, transportation and marketing of seeds. Seed certification, seed certification agency, phases of seed certification, Indian Minimum seed Certification standards, seed sampling, testing and granting certification, OECD certification Schemes.

Unit-8: Postharvest Management and Value Addition of Vegetable Crops

Importance and scope of post-harvest management of vegetables, maturity indices and standards for different vegetables, Methods of maturity determination; Biochemistry of maturity and ripening, Enzymatic and textural changes, Ethylene evolution and ethylene management, Respiration and transpiration along with their regulation methods, Harvesting tools and practices for specific market requirement, Postharvest physical and biochemical changes; Pre harvest practices and other factors affecting postharvest losses, Packing house operations: Commodity pretreatments chemicals, wax coating, precooling and irradiation, Packaging of vegetables, prevention from infestation, management of postharvest diseases; storage disorders chilling injury and principles of transportation, Methods of storage- Ventilated, refrigerated, modified atmosphere and controlled atmosphere storage, hypobaric storage and cold storage; Zero-energy cool chamber. Quality control- Quality assurance and quality control, TQM, GMP; Food standards- FPO, PFA, etc., Food laws and regulations, Food safety- hazard analysis and critical control points (HACCP), Labeling and labeling act and nutrition labelling Value addition Major value added vegetable products, Utilization of byproducts of vegetable processing industry, Management of processing industry waste, Investment analysis; Principles and methods of sensory evaluation of fresh and processed vegetables.

Agricultural Extension

Unit-1: Fundamentals of Extension Education, Communication and Diffusion of innovations

Genesis and evolution of extension in India and worldwide, Extension Education and Advisory Services concepts and principles. Extension approaches for sustainable development in agriculture, veterinary & animal husbandry, fisheries and community science driven livelihoods systems in India and other countries, National Agricultural Extension System and Reforms, Public extension systems-ATMA and KVK, National Mission on Agricultural Extension and Technology, Private extension system: Pluralism in extension, Farming System Research & Extension; Agricultural Knowledge and Information system (AKIS), Farmers Field School, participatory technology development, Technology assessment and refinement, Agricultural, Veterinary & Animal Husbandry, Dairy, Fisheries, and Rural Development Programmes implemented by Govt. of India. Basic rural institutions social structure; culture and norms: Social change processes, Group dynamics. Communication Concepts, functions, elements, processes, models, theories, types, skills, problems and harriers. Social networks in communication, Development communication- need, concept, component, theories, and scope in India. Diffusion of Innovations concept, elements, models, and theories, Innovation development process, Adoption concept, process, models, adopter categories and their characteristics, Factors influencing adoption, diffusion network-opinion leadership, models of communication flows, communication network analysis and theories: Change agents, Innovation-decision process, Innovations in organization, consequences of innovations: reinvention, grassroots innovations, Enabling innovation.

Unit-2: Extension Methods, ICT & Educational Technology

Concepts of Andragogy and Pedagogy, Human behavioral dimensions in extension Behaviorism, Cognitive, Constructivism, factors influencing human behavior. Types of learning, domains of learning-cognitive, affective and psychomotor, Learning theories Experiential learning. Concepts and elements of teaching and learning processes, principles of learning. Cone of Experience, Classification and features of extension methods, Selection, planning and use of extension methods. Agricultural journalism-concept and theories, types of publications, basics of writing, editing, readability- Gunning Fog Index. Fundamentals of layout and design, Preparation of radio/video script. Photo-journalism, Journalistic ethics. Information and Communication Technology (ICT) -concepts and application in extension and advisory services, ICT tools-print and electronic media, community radio, Social media- features and applications, Websites, portals, Expert system and Apps related to agriculture, dairy, veterinary, fishery and marketing etc. m-Learning, e-learning, e-Learning platforms - MOOCS, OER, etc. Digital agriculture applications of Artificial Intelligence (AI), IoT, GIS, GPS, Block Chain Technology, Big data analytics in extension. Educational and instructional technology concepts, models and theories: Creating instruction; planning. designing and implementing the curricula and learning experiences, needs analysis, task and content analysis, learner analysis, Instructional techniques and strategies- Program Instruction Techniques, organizing content and learning activities; Multi-media learning- concepts, theories and models: Approaches to interactive design.

Unit-3: Research Methodology in Extension Education

Meaning of research and theory: Types of research; Stages of social research, Research problems and problem statements, Stating and testing of hypothesis, Meaning and types of variables; operational definitions, Meaning,

principles, elements and criteris of research design, MAXMINCON Principle; Types of research designs, Threats to internal and external validity, Measurement meaning, postulates and levels of measurement; Reliability and validity of instruments, Sampling designs Probability and non-probability sampling: determination of sample size; factors affecting choice of sampling designs, Sampling and Non-sampling errors, biases, Methods of observation Interviews, sociometry, semantic differential, Q methodology, projective techniques, focus group discussion, participant and non-participant observation, Scaling techniques-Classical test theory and item response theory, methods of scale construction; scalogram analysis, multi-dimensional scaling: use of factor analysis in scale development, development of knowledge test, Methods of constructing indexes, Qualitative research ethnographic, grounded theory. Phenomenological, Behavioral modeling, Nudge theory, Content analysis discourse analysis, narrative research: Parametric and non-parametric statistics for data analysis in social research: Social Network Analysis, Multi-criteria methods, Research report writing; Ethics in extension research.

Unit-4: Extension Management and Organizational Behavior

Meaning, concept, theories and principles of administration and management. Functions of management planning, organizing, staffing, directing and leading, controlling. coordinating, reporting and budgeting. Decision making. Leadership styles and theories; Delegation and decentralization, Organizational Structure, Organizational Design, Organizational Communication: Organizational Culture vs. Climate, Characteristics of Organizational Culture, Creating and Maintaining Organizational Culture, Organizational Change, Organizational learning and Transformation; Motivational Theories & Techniques, Work motivation; Performance appraisal, Job satisfaction and morale, Time management, Problem Solving Techniques/Negotiation, Individual and group behavior in organization Team building process, Organizational development, Interventions for organizational development, Managing Stress, conflict and Emotions, Creativity concept and process

Unit-5: Training and capacity development

Training Concept and types, Training Need Assessment-Concept, Methods and Process; Types of need assessment, Training Process-different phases of training, models of training. Designing training curriculum, Training strategies-Academic Strategy, Laboratory Strategy, Activity strategy, Personal development strategy. Organizational development strategy; Training Methods-Lecture, Discussion, syndicate, seminars, Panel Discussion, Conference, Symposium, Role Play, Case Study, Brain storming, Programmed Instruction, T-Group/Laboratory methods; Factors Determining Selection of Methods; Evaluation of training; Need and principles of capacity development; process of capacity development; levels of capacity- individual, organization, enabling environment; Human resource development-manpower planning. Role analysis, Role Efficacy, Induction, training. Job enrichment, self-learning mechanisms, counseling, mentorship. Performance appraisal and feedback.

Unit-6: Technology Commercialization, Incubation and Entrepreneurship Development Technology transfer vs commercialization; Technology commercialization process and approaches, Technology incubation- meaning, type, functions and process; Technology scouting, National IPR Policy: National Biodiversity Act (2002); Protection of Plant Varieties and Farmers Right Act (2001). Entrepreneurship-concepts, characteristics, and theories; Entrepreneurial Characteristics and Motives, Entrepreneurial competencies; Entrepreneurial motivation; Simulation games and exercises for developing entrepreneurial competencies, Entrepreneurship development cycle;

Entrepreneurial environment; barriers to entrepreneurship, forms of business ownership, Elements of project formulation- feasibility analysis, techno-economic analysis, project design and network analysis, input analysis, finance analysis, social-cost benefit analysis, project appraisal. Enterprise management- management skills, production management, financial management, Development of a marketing plan, pricing concepts and pricing strategy, Consumer behavior, Market Intelligence, Marketing communication and promotional strategies, Life cycles of new business, environmental factors affecting success of a new business. Government policy for small scale enterprises and women entrepreneurship development: National Policy on Skill Development; Start-up India, Make in India, Digital India, Atal Innovation Mission and others, Government support and services for entrepreneurship development in agriculture dairy, fisheries and community science. Corporate Social Responsibility, Venture Capital Fund for entrepreneurship in agriculture, dairy, and fisheries, Social entrepreneurship.

Unit-7: Program development, evaluation and impact assessment Program planning and development-concepts and steps, Logic framework approach (LFA); Program Evaluation- concept, objectives, principles, criteria, and theories. Difference between monitoring and evaluation, Evaluation process; Steps in Programme evaluation; Types of Evaluation. Objective Oriented, Management Oriented, Context Evaluation, Input evaluation, Process Evaluation, Product Evaluation, Consumer oriented evaluation, Expertise Oriented Evaluation, Adversary Oriented Evaluation, Naturalistic and Principal oriented evaluation, goal free evaluation and meta evaluation; Levels of Bennett's hierarchy; Evaluation models; Programme management techniques, SWOT analysis, Bar Charts, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), differences between PERT and CPM, advantages and disadvantages. Defining impact, Social Impact Assessment-stages and approaches, Theories of change, Criteria and indicators, Quantitative and qualitative techniques for impact assessment:

Unit-8: Developmental Policies, Strategies and Issues in Extension Importance of extension policies, Role of extension in influencing policies, Policy advocacy strategy and approaches, Policy analysis types, process, methods and techniques. New approaches and domains of extension-demand-driven extension, market-led extension(value chain extension), farmers-led extension, group-led extension, gender sensitive extension; roles and approaches of extension for enhancing capacity for climate change adaptation; promotion of conservation agriculture, nutri-sensitive agriculture, agri-preneurship, agri-tourism, and urban and peri-urban agriculture, Extension through public private partnership (PPP); Changing role of extension in the context of globalization and IPR, Extension and Sustainable Development Goals (SDGs), Sustainable rural livelihood

Unit-9: Gender Sensitization and Empowerment Concepts of Gender- gender roles, gender equality, gender equity, gender relations, gender balance, gender bias, gender blindness, gender needs- practical and strategic, issues in agriculture and extension; Gender mainstreaming- approaches and methods, gender analysis framework and tools; Gender empowerment measures, dimensions and methodologies for empowerment, gender impact assessment, gender budgeting, gender specific technologies, gender dimensions in food and nutritional security, Women's empowerment- principles, framework and dimensions, Strategies and barriers for women empowerment, empowerment through SHG, financial inclusion, micro-finance, internet and education, women entrepreneurship, Public-Private Partnership for the economic empowerment of women, Building rural institution for women empowerment, Women rights, constitutional provisions. Global and National policies and mission for empowerment of women; Government programmes and schemes for women, children and youth.

Home Science

Unit-1: Human Nutrition, Health and Interventions

Macro and micro nutrients in human nutrition; Carbohydrates, dietary fibre, proteins, lipids, vitamins, minerals and water requirements, sources, functions, digestion, absorption acclimatisation, metabolism and effects of deficiency and toxicity, Hormones (chemistry. metabolism, mechanism of action); Nucleic acid, molecular aspects of nutrient transport. Glucose homeostatic, glycaemic index, nutrient turnover. Energy Balance. Bioenergetics, energy expenditure, thermo genesis, regulation, requirement, BMR Metabolism of hunger. Nutrients inter-relationship. Inborn errors of metabolism. Phytochemicals, antioxidants, prebiotics and probiotics, functional foods, genetically modified foods, nutraceuticals and health foods. Balanced diet. Establishment of Recommended dietary allowances. Meal planning: Normal nutrition: pregnancy, lactation, infancy, preschool age, adolescent, adult and old age. Materno-fetal nutrition: physiology and nutrient demands of mother-child dyad. Physical fitness and sports nutrition. Diet & nutritional therapy. Food allergies and intolerances, trauma and burns. Oral and preantral nutrition. Infection and immunity. Eating disorders. Major public health and nutritional problems in India- Global nutritional problems. Nutrition in emergencies and natural calamities. Assessment of nutritional status anthropometry (measurement techniques, Indices and cut-off points), biochemical, clinical and dietary assessment. Body composition analysis, National Nutrition Policy current policies and formulation. National and International organization's programmes to combat malnutrition. Nutritional epidemiology: biostatistics, planning epidemiological studies for policy formulation. Public health aspects of human nutrition. Nutrition education objectives, principles and importance. Nutrition Intervention: importance, methods, nutrition monitoring and surveillance. Nutrigenomics: scope and importance

Unit-2: Food Science and Processing Technologies

Food: Physico-chemical properties, methods, merits and demerits of cooking, Food

Chemistry: chemical properties of food. Sensory evaluation and consumer acceptability of foods by subjective and objective methods. Food fortification, enrichment and supplementation. Food additives and Preservatives. Anti-nutritional factors & Toxicants in foods. Food quality: hygiene and sanitation, food-borne illnesses, infections and food poisoning: food adulteration and detection, food standards (FSSAI), laws & regulations for food safety, HACCP and good manufacturing practices (GMP). Post harvest losses, food spoilage and its causes. Food processing techniques: Principles and methods of food processing for different food groups drying, concentration, freezing, cryogenic freezing fermentation, irradiation, canning, sterilization, pasteurization, ohmic heating, bakery and confectionery, effects on nutritional value, food packaging and labelling. Storage of perishable and non-perishable foods, traditional and modern food storage. Role of FCI in public distribution system. Recent advances in food science and technology: micro, nano and ultra-filtration, membrane technology, hurdle technology. Processed and convenience foods. Food analysis: Techniques, principles and methods for nutrients, ant nutrients and photochemical

Unit-3: Apparel and Textile Science

Fibre polymer chemistry, structure property relationship of natural, manmade & synthetic fibers; Nano and micro fibers and their production, Fiber Blending. Bi-component and bi- constituent fibers, High performance fibres, Technical textiles, Textile quality analysis, fiber, yarn and fabric testing, apparel quality control, Product development, testing, economics, standards/specifications; National and International organization for standards: Principles of weaving; looms; basic, textured and decorative weaves; woven designs, peg plans & weaving calculations, specialty fabrics; Knitting- principles, classification and knitting machines; Non- wovens- types, properties, finishing, application and testing, Chemistry of dyes and pigments; advanced dyeing and printing techniques, natural dyes, dyeing parameters, Colour science and theories of dyeing, Colour measurement systems, Whiteness, yellowness, brightness and fastness of colour, Computer colour matching, Textile finishes scope, importance and classification; Surface active agents, Dyeing, printing and finishing auxiliaries, Traditional textiles, costumes and accessories of Egypt, Greece, Rome, France, Japan, America and China. Aspect of Functional clothing and clothing comfort, Heat transfer, clothing systems for thermal insulation and protection; Designing functional clothing for special needs and various occupations, sports and impact protective clothing.

Advanced techniques of pattern making and draping. Principles and techniques of contouring, pattern grading and fitting. Textile ecology, Eco-balance, coo textiles and sustainability, Indian and International environmental legislations, Eco labeling, management and auditing: treatment and disposal of textile effluents, Textile conservation- examination,

damage causing agents, condition, assessment, repair and stabilization of textiles, materials and equipment, Principles of cleaning, storage and display of fragile textiles.

Socio-psychological, health and sanitation aspects of clothing. Consumer behavior and marketing concept in relation to fashion and clothing, Development, status, classification, infrastructure & managerial techniques of Indian textile and garment industry, cost and productivity analysis, automation, use of CAD/CAM and robotics in textile industry, Merchandising, positioning and branding. Production and operations management in textile and apparel, Plant location, material handling and work study, Government initiatives on various apparel and textile sectors and EXIM policies

Unit-4: Human Development and Family Studies

Theoretical framework and critical review of different theories of human development- classical, contemporary and life span theories, Basic concepts and issues of human development-psycho-social perspective, Ecological modeling-physical, economic, socio- cultural and socio-political role of ecology in life course development; Current and classic research trends in human development and family studies, Models of intelligence and early brain development. Adolescent development and challenges: Developmental assessment-concepts,functions,characteristics and methods, Developmental tests and scales-types of measurement scales, standardization procedures, validity, reliability and ethical issues in the assessment, Need and scope of innovative programmes in early childhood development and education, Current innovative programmes at State, National and International level; Differently abled- etiology, developmental characters, classification, statistics, educational provisions, vocational interventions and government support services; Developmental intervention-theoretical

frameworks and intervention models, Vulnerability, resilience, risk and protective factors; Guidance and counselling- meaning, history, goals, levels, techniques, areas, types, approaches and theories, Adulthood-developmental and theoretical perspectives, Gender studies issues,gender discrimination indicators and gender development index, Family- theoretical framework, perspectives, transitionsand socialization, Parent child relationships-functional and dysfunctional dyads, models of parenting, Family stressors and resilience- impact of consumerism, emigration and multiculturalism, Cross-cultural variations in family functioning-theories and issues, Marriage- legal provisions, laws, adoption, divorce and inheritance; Family therapy orientation, theoretical perspectives, types, concerns and prospects, Mental health- theories, issues, disorders, programmes, policies, behaviour assessment and modification.

Unit-5: Family Resource Management and Consumer Science

Management-Significance, scope, theories and functions, Management principles, Managerial akills and roles; Management process. Organizational behaviour Values Attitudes and performance: Decision making-Models of decision-making behaviour, Leadership characteristics, styles; theories and types: Conflict resolution strategies and management, Menagerial ethics and social responsibilities, Motivation- importance, contemporary theories of motivation; Effect of interior design on user comfort-residential, commercial and special needs, Functional and aesthetic consideration in the use of clements and principle of design, Recent developments in building bye-laws; energy efficient buildingdesign, Green building design, Energy efficiency building regulations, Policies and institutional support for people with special needs. Consumer behaviour, Factors affecting buying behaviour, Models of consumer behaviour, New economic policies-liberalization, privatization, globalization, Consumer services- citizen charter, GST: Budget and economy, Methods of measurements of national income, National income and Economic welfare Taxation, Inflation and Deflation- meaning, types, causes, effects: Measures to control, Difference between global and international market, Gender issues in consumerism, Green Consumerism-meaning, objectives and need, Consumer protection measures- legal and non- legal consumer legislation, Trends and impact of advertising on consumers; Legal and ethical aspects of advertising in India; Women's economic, social and cultural rights, National and International initiatives for women's economic empowerment, Effect of technology on environment, Global environmental issues and challenges climatic change, global warming, population, land degradation, exploitation of natural resource, ozone depletion, acid rain, nuclear power, oil spill pollution, dumping of hazardous waste. nvironmental Management System- carbon credit, environment standards, Environmental waste management, Energy policy of India.

Unit-6: Occupational Ergonomics

Ergonomics Definition, aim, objectives and scope, Anthropometry and Biomechanics in ergonomics and design: Body movement and posture; Work physiology, Application of biomechanics to movement- qualitative and quantitative approach; Introduction to components of worker input- affective, cognitive, temporal and physical; Principles of workstation and system design, Design and arrangements of different work centres, Product design: Design consideration in product design for people with special needs. Workplace risk factors and hazards types, source and classification, Tools and techniques for identifying risk factors

related to forceful exertion and repetitive motions, Postural discomfort and its impact on hurman health: posture analysis tools, Work related musculoskeletal disorders. Physical work capacity and workload measurement, Ergonomic task analysis, Methods for integrating ergonomics into existing occupations, System approach to ergonomics, Visual ergonomics and its advantages, Effect of environmental parameters on work, worker and work performance and its management

Unit-7: Extension Education and Communication Management

Fundamentals of Extension education, Indian Extension systems ICAR, Ministry of Rural Development, Ministry of Agriculture and Farmers Welfare, NGOs, Rural development programmes in India before and after independence, Paradigm shift in extension approaches and systems; Recent trends in extension; Extension management and training organisations and institutions, Diffusion and adoption of innovations, Development communication; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs); Role of ICT in commUnity education: new media and multimedia; Transfer of Technology: forms, models and process of technology transfer, Technology development and management process, Technology assessment and refinement, Communication process and skills verbal, non verbal and written communication; Scientific communication: Formats of scientific writing, Writing for scientific journals and ratings of journals, Participatory programme management, Project management techniques, Monitoring and evaluation of extension programmes, Educational technology concept, teaching learning process, styles and strategies, ICT application in education; Group dynamics and management, CommUnity Development and outreach concept principles and approaches, Organisational development and HRD mechanism. processes and outcomes; Mobilization and empowerment, Gender sensitization for empowerment; Gender issues and toolkit for assessment; Concept of climate and climate change, Greenhouse gases and global warming. Impacts of climate change, Climate change policies in India; Concept, process and functions of management Skills for effective managerment of extension activities and organizations, Strategic planning; Management by Objective (MBO); Unified Talent Management (UTM); Self-Directed Micro Learning (SDML); Total Quality Management (TQM), Management of information system, Creativity and problem solving, motivational skills, Impact assessment of development programmes, Research inethodology in extension and communication: Research designs, Sampling techniques, Tools of research; Scaling techniques for behaviour research: Levels of measurement, Techniques of scale construction- Likert scale, Thurston scales, Measurement of reliability and validity of scales, Sustainable development Concept, principles, indicators and dimensions; Sustainable livelihood systems, Extension research project management: concept, models, approaches and tools; Media application and product promotion: Online and offline promotional strategies.

Animal Husbandry

Dairy Technology

Unit-1: Milk and Milk Products

Current status of dairy industry in India, Manufacture, packaging, storage, defects, sensory evaluation and quality analyses of liquid milk products, traditional Indian dairy products. cheeses, fermented milks, fat rich dairy products, ice cream and frozen desserts, by-products of the dairy processing operations, condensed and dried milk products.

Unit-2: Advanced Dairy & Food Processing

UHT processed milk products: properties and prospects, equipment, heat stability and deposit formation, effect on milk quality, Principles and equipment for bactofugation and bacto-therm processes; Partial/High Pressure Homogenization and its application in dairy industry, Microfluidization of milk; Concentration processes and their impact on quality of finished products, Advances in drying of milk and milk products. Freeze drying: physico-chemical changes and industrial developments; Hurdle technology and its application in development of shelf-stable products; Use of carbonation in extending the shelf life of dairy products, Advances in bakery processing: Application of dairy ingredients in bakery and confectionary products: Technological aspects and issues in fermented foods and beverages; Extrusion processing of food and dairy products, Advances in cleaning and sanitization of dairy equipment: Bio-films, Bio-detergents. Innovations in sanitizers chemical, biological, radiation: Assessing the effectiveness of cleaning and sanitization of dairy equipment.

Unit-3: Alternate Processes For Dairy and Food Industry

Non-thermal processing technologies for food: Irradiation, High frequency heating, Infra-red (IR) heating. Ohmic heating. Ultrasonic treatment, High hydrostatic pressure processing. Pulsed electric field processing: Their principles, effect on food constituents and salient applications in food sector industry, Enzymes in dairy and food processing: Newer concepts in food processing including organic foods: Processing of organic raw material; Genetically modified foods; Space foods; Nutrigenomics, metabolomics and other Omics concepts in dairy and food processing.

Unit-4: Dairy and Food Packaging

Trends in packaging industry; Testing of packaging materials; Adhesives; Graphics; Coding (Barcode and Quick Response code) and labeling used in food packaging; Protective packaging of foods; Effect of light, oxygen and moisture on packaged food; Packaging of dairy and food products; Modified atmosphere packaging: Shrink and stretch packaging, Self-heating and self-cooling cans; Retort pouch technology; Microwavable, biodegradable, packaging; Industrial packaging Unitizing, palletizing, containerizing. distribution systems for packaged foods; Safety aspects of packaging materials; Sources of toxic materials and migration of toxins into food materials; Interaction of food flavours with packaging.

Unit-5: Functional Foods, Nutraceuticals, Novel Dairy Ingredients

Milk nutraceuticals and functional foods: Trends, market, classes, mechanisms of action and applications, Milk fortification; Developments in Infant formula and complementary foods, Geriatric Foods, Sports foods, Dairy foods for metabolic disorders: Reduced calorie foods. Low sodium and low lactose foods Herbs and phytochemicals for fusion health foods; Bioactive ingredients from milk, Probiotic, prebiotic and synbiotic foods.

Unit-6: Process Control for Product Monitoring

Product-Process Monitoring in dairy and food industries; Quality-prediction model based on quality kinetics and process state equations, simulation modelling, Process/Product Optimization optimization procedures: Process Control: objectives, control loop, loop elements and their functions, modes thereof, Techniques and equipment. Real-time instrumentation: sensors, biosensors, time-temperature indicatory (TTI), E-Nose and E- Tongue, Advanced analytical techniques Gas Chromatography-Olfactometry, GC-MS, LC- MS, NMR, FTIR: Principles and applications of Differential Thermal Analysis, Differential Scanning Calorimetry, X-ray crystallography, circular dichroismspectroscopy, dynamic light scattering, laser diffraction, image analysis, Nucicar Magnetic Resonance, Principles and applications emerging spectroscopic techniques for evaluation of foods Automated milk analyzers: Colour Chameterization: Principles and applications of colour and appearance through mstrumentation hap

Unit-7: R & D Management in Dairy and Food Industry

Global scenario of R&D efforts in dairy processing: Determinants of Consumer Preferences; Competitive positioning and value chain configuration in global market, Structure and design of R&D organization, Analysis of organization behavior. Transactional analysis; Personnel management: Typology analysis, individual and the organization, team building, human behaviour at work, motivation: Skill requirements of an R&D manager, New product development strategies, models and life cycle analysis; Food innovation dynamics: Criterion for selection of R&D projects, Technology development process, Techniques for monitoring R&D functions, Intellectual property rights: Indian Patenting Act, International patenting laws; Technology commercialization, Quality management systems.

Livestock Production and Management

Unit-1: General

Development of livestock industry, its present status and future prospects in India and world. Domestication and adaptation of livestock in different agro-climatic zones. SWOT analysis of the livestock sector. Livestock production systems in vogue under Indian conditions and world. Various livestock development programs in India. Biotechnological interventions for livestock improvement. Organic livestock production. Integrated farming system.

Unit-2: Breeding Management

Breeds/ strains of cattle, buffalo, sheep, gout, pig, yak, mithun, horse, donkey, camel, dog, cat and laboratory animals with emphasis on economic importance. Basic principles of inheritance. Concept of heritability, repeatability and selection. Methods of selection and systems of breeding in farm animals. Role of crossbreeding in evolving new breeds. Traits of economic importance and their inter-relationships. Database management and

application of breeding related software. Recent advances in breeding management. Artificial insemination and its techniques.

Unit-3: Feeding Management

Nutrients and their function. Nutritional requirement, formulation and compounding of ration. Various feeding standards. Feed and fodder resources for livestock, wild life and laboratory animals. Feed and fodder requirements of different categories of livestock, wild life and laboratory animals. Scientific technique and regimen of feeding and watering of different categories of livestock and laboratory animals. Supply of green fodder round the year. Enrichinent of poor quality roughages. Non-conventional feeding resources. Pasture management. Feed supplements and additives. Least cost ration formulation and feed conversion efficiency. Storage, conservation and preservation of feeds and fodders. Recent approaches in feeding, phased feeding and eco-feeding. Hydroponic fodder. Feeding of agro- industrial by-products. Standards of drinking water, water hygiene and efficient water usage mechanisms.

Unit-4: Reproduction Management

Reproductive systems of farm animals. Heat detection and early pregnancy diagnosis methods Causes, prevention and management of anestrus, infertility, sterility and calving difficulties Optimizing age at first calving and calving interval. Improving breeding efficiency of livestock Recent approaches in breeding and reproductive management of livestock. Optimization of reproductive traits. Artificial insemination. Recent advances in reproductive biotechnologies. MOET, cloning, estrus synchronization, sexed semen, IVF.

Unit-5: Livestock and Environment

Weather, climate and environment. Adaptation and acclimatization of livestock. Livestock and global warming. Agro-climatic regions of India and livestock performance. Climatic stress in livestock (heat stress/ cold stress); effects, measurement and amelioration. Temperature- humidity index and thermo-neutral zone. Micro and macro environment. Micro-climate modification in animal houses. Effect of climate change on animal production. Climate-resilient livestock production systems. Effects of Natural disasters on livestock and mitigation measures. Water, carbon footprints and carbon sequestration of farm animals and products Mechanism and opportunities of carbon trading in the livestock sector. Assessment of livestock impact on environment in different production systems. Farm animal, slaughter house and tannery waste. Strategies for mitigation of methane emission from the livestock sector. Selection for heat tolerance. Recent advances in shelter management under impending climate change.

Unit-6: Housing Management

Housing systems and standards (BIS) for livestock. Equipment requirements for different classes of livestock farms. Layout plans and construction details for different sized livestock farms in various agro-climatic zones of India. Advances in housing management related to design, layout, construction materials, cost of construction, climate resilience, heat & cold stress and behavior & welfare of animal. Low-cost animal houses. Ideal sheiter management practices for better productivity. Advances in manure, waste and carcass disposal and utilization.

Unit-7: Livestock Behavior and Welfare

Evolution, importance and theories of animal behavior Favorable and un-favourable behaviour of domestication. Behaviour assisted animal management. Behavior based whak

housing designs. Vices and stereotypes Social hierarchy and aggression. Species-specific behavior in relation to season and physiological condition for better productivity and welfare Animal welfare, rights and freedoms. Indicators of animal welfare. Welfare of livestock in commercial farms and captivity. Environmental enrichment. Welfare of livestock during various management activities like handling, transportation, etc. Legislation and regulations of animal welfare. Evaluation of animal welfare measures as an 'instrument' of good animal husbandry, production of quality products and enhanced income to farmers.

Unit-8: Herd Health Management

Symptoms of ill health. Prevention and control of important infectious diseases. Hygiene and sanitation of livestock farms. Vaccination schedules. Internal and external parasites and their control. Common disinfectants used in livestock farm. Foot bath, dipping & wheel dip. Concept of first aid. Segregation and quarantine management of animals. Quarantine act for zoonotic diseases. Labour health programme. Bio-safety and security measures. Recent advances in herd health management.

Unit-9: Livestock Farm, Laboratory & Companion Animals

Routine management practices (general, housing, feeding, breeding, cleaning) and labour management of livestock, laboratory& companion animals, wild life and zoo for different categories of animals. Conservation of indigenous germplasm. Animal judging. Body condition score. Establishment of Livestock Enterprises of different sizes for various economic strata. Advances in livestock management. Transportation for various purposes. Milking management & clean milk production. Sanitary and phytosanitary standards for the production of quality milk. Draughtability and advance management of draught animals. Salvaging of buffalo calves. Small ruminants management; production systems, prospects under stall feeding, slaughter management (methods, carcass traits, by-products). Swine production; production systems, slaughter management (methods, carcass traits, dressing %, by-products). Equines; ownership, foot and dental care, training, exercising, doping, regulatory acts in disease control and welfare, race clubs, transportation, import and export. Compamon animals; ownership, traming, preparation of animals for show, judging, kennel clubs, hostels, parks.

Unit-10: Precision Livestock Farming

Precision Livestock Farming; scope and limitations. Animal identification and tracking. Sensor systems and ICTs in animal health, productivity and welfare. Use of virtual fencing, GPS and GIS in precision livestock faming. Early warning systems for animal health and welfare. Livestock farm machineries with their functions. Tractor& trolley, scraper, milking machine. mower, field chopper, chaff cutter, fogger, mister, sprinkler, forage harvester.mechanical hay drier, conventional baler, hay stacker, straw combine, sewage and water pump, electrical switch & gears, feed plant machines, weighing bridge, automatic feeder and waterer, milk storing equipment, shearing machine, TMR and CFB machine. Use of non- conventional energy at livestock farm. Application of roboties in livestock. Software for database management, computation and analysis.

Unit-11: Entrepreneurship in Livestock Sector

Management principles. Factors of production. Livestock production economics; supply and demand. Cost of production. SWOT analysis for different livestock species. Profit maximization. Livestock marketing, newer concepts, advertising research, market surveillance. Marketing channels and laws. Pricing strategies& supply chain management. Livestock entrepreneurship, concept, characteristics, role in relation to enterprise, functions, limitations. Process and criteria of entrepreneurship development in livestock sector (techno- economic feasibility of enterprises, training and management skills, business acumen, business communication, inter-personnel skills etc.). Institutional interface in the development of entrepreneurship, incubation centres, startups, PPPs in the livestock sector. Entrepreneurial training development programmes at the State and National level. Livestock Insurance. Financial credit and management. Bank and Government support for entrepreneurship. Analyzing project, appraisals and reports, capital, expenditure decisions, reinvestment and payback. Preparation of hankable projects and profit assessment.

Plant Protection

Agricultural Entomology

Unit-1: Systematics

History and development of Entomology, Evolution of insects, position of insects in the animal world, characteristics of phylum Arthropoda, structural features of important arthropod groups such as Trilobita, Chelicerata and Mandibulata, structural features of important classes of phylum Arthropoda viz. Arachnida, Crustacea, Chilopoda, Diplopoda and Hexapoda. Classification of insects up to order level, habits, habitats and distinguishing features of different Order and important Family detailed study of three schools of classification-numerical, evolutionary and cladistic. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography. Study of different views on the evolution of insects-alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times. Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN; scientific ethics. Nomenclature and documentation protocols and procedures; report preparation on new species; deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories-requirements and procedures. Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications - small publications of species descriptions, works on revision of taxa, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular taxonomy, barcoding species and the progress made in molecular systematics. Multivariate analysis for clustering of specimens; rooting & character polarisation for developing cladograms; use of computer programs for development of cladograms.

Unit-2: Morphology

Body wall, its structure, outgrowths, endoskeleton, Body regions, segmentation, sclerites and sutures. Head and head appendages, types of mouth parts, antennae, their structure and types. Thorax structure, thoracic appendages and their modification Wings, their modification and venation, Abdomen, structure, abdominal appendages both in Pterygota and Apterygota External genitalia, general structure and modification in important insect orders. Immatures stages: types ecological and evolutionary adaptation.

Unit-3: Embryology, internal anatony and physiology

Embryonic and post embryonic development, types of metamorphosis, physiology of ecdysis. General features and types of larvae and pupae Structure, function and physiology of Digestive, Circulatory,

Respiratory, Reproductive, Nervous and Excretory systems, Sense Organs; structure and types. Insect food and nutrition, minerals, carbohydrates, proteins and amino acids, lipids, vitamins and their role in growth and development, artificial diets. Biosynthesis of chitin, chitin protein interactions, Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development: physiology of excretion and osmoregulation, water conservation mechanisms. Physiology of endocrine system, role of endosymbionts, biochemistry and MOA of behaviour modifying chemicals. Defence mechanism in plants against insects

Unit-4: Ecology

Concept of ecology, Environment and its components-biotic and abiotic factors and their effects on growth, development, population dynamics, distribution and dispersal. Principle of biogeography and insects biodiversity. Biotic potential and environmental resistance. Ecosystems, agro-ecosystems analysis, their characteristics and functioning. Intra and inter specific relationship; competition, predator-prey and host-parasite interactions, ecological niche. Life table studies, population models. Food chain and food web. Arthropod population monitoring, pest forecasting. Diapause and causes of pest out breaks.

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Meaning of stress-plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses. Host seeking behavior of parasitoids.

Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory. Marginal Value Theorem, and Patch departure rules, central place foraging. Mean- variance relationship and foraging by pollinators, Nutritional Ecology.

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies-timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecologicalvs Natural Ecosystems-Characterisation, Pest Control as applied ecology-case studies. Conservation, reproductive ecology, evolution of herbivory, stress ecology.

Unit-5: Biological control

Importance and scope of biological control, history of biological control: Biocontrol agents- parasites, predators and insect pathogens. Important entomophagous insect Orders and Families. Ecological, biological, taxonomic, legal and economic aspects of biological control, phenomena of multiple parasitism, hyperparasitism, superparasitism and their applied importance. Principles and procedures of using exotic biocontrol agents. Utilization of natural biocontrol agents: conservation, habitat management and augmentation. Mass multiplication techniques and economies. Effective evaluation techniques, Biocontrol organizations in world and India. Successful cases of biological control of pests. Entomophilic pathogens: bacterial, fungi, viruses, rickettsiae, Protozoan and nematodes, Modes of transmission, methods of uses, symptoms of infection. 4 Microbial insecticides and their formulation. Merits and demerits of microbial control. Role of biocontrol agents and microbial insecticides in Integrated Pest Management. Nutrition of entomophagous insects and their hosts, dynamics of bio-agents vis- à-vis target pest populations.

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in bio-control agents for introgressing and for progeny selections, breeding techniques of bio-control agents.

Risk analysis in augmentative biological control; evaluation of BC programs analysis and feasibility; risk assessment of natural enemies in BC; habitat manipulation for suppression of populations; role of endophytes and endosymbionts in BC; resistance to microbial pathogens

Unit-6: Chemical control and toxicology

History, scope and principles of chemical control. Insecticides and their classification. Formulations of insecticides. Susceptibility of insects to the entry of insecticides. Physical,

chemical and toxicological properties of different groups of insecticides: chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, chlordimeform, chitin synthesis inhibitors, avermectins, nitroguandines, phenylpyrrozzoles, botanicals (natural pyrethroids, rotenone, neem products, nicotine, pongamia spp. etc). Combination insecticides. Problems of pesticide hazards and environmental pollution. Safe use of pesticides, precautions and first aid treatments. Insecticides Act 1968, registration and quality control of insecticides. Evaluation of toxicity, methods of toxicity testing, determination of LD 50, LT 50, RL 50 etc. Pesticides residues in the environment and their dynamics of movements, methods of residue. Pharmacology of insect poisons. Mode of action of different groups of insecticides; neuroactive (axonal and synaptic) poisons, respiratory poisons, chitin synthesis inhibitors. Metabolism of insecticides; activative and degradative metabolism, detoxification enzymes and their role in metabolism. Selectivity of insecticidal actions; insecticide resistance; mechanism, genetics and management of insecticide resistance.

Penetration and distribution of insecticides in insect systems, developments in bio-rational approaches; SPLAT: RNAI technology for pest management. Biopesticides and newer molecules; their modes of action and structural-activity relationships; advances in metabolism of insecticides. Insecticide laws and standards and pesticide bill

Unit-7: Host plant resistance

Chemical ecology: mechano and chemo receptors. Host plant selection by phytophagous insects. Secondary plant substances and their defenses against phytophagous insect. Basis of resistance (Antixenosis, Antobiosis, Tolerance). Biotypes development and its remedial measures. Tritrophic interactions, induced resistance. Breeding for insect resistant plant varieties. Resistance development and evaluation techniques. Genetics of Resistance: vertical resistance, horizontal resistance, oligogenic resistance, polygenic resistance. Biotechnological approaches and development of transgenic insect resistant plants, its advantages and limitations. Case histories. Insect resistance to transgenic plants and its management.

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species-gene pool; insect sources -behaviour in relation to host plant factors.

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways, effects of induced resistance; exogenous application of elicitors. marker aided selection in resistance breeding, biochemistry of induced resistance.

Estimation of plant resistance based on plant damage-screening and damage rating, evaluation based on insect responses; techniques and determination of categories of plant resistance, breakdown of resistance in crop varieties

Unit-8: Innovative approaches in pest control

Behavioral control: pheromones-types and uses, advantages and limitations. Hormonal control types and function of insect hormones, insect hormone mimics, advantages and limitations. chemosterilants, antifeedants, attractants, repellents, their types, method of applications, advantages and limitations. Genetic control: concepts and methods, case histories, advantages and limitations. Potentialities of IPM.

Unit-i: Defining Behaviour Concept of umwelt, instinct, fixed action patterns, imprinting. complex behavior, inducted behavior, learnt behavior and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behavior- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behavior and behavioural polymorphism

Unit-ii: Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

Unit-iii: Reproductive behavior- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios, Social behavior-kin selection, parental manipulation and mutualism, Self organization and insect behavior.

Unit-iv: Foraging- Role of different signals in host searching (plant and inseets) and host acceptance, ovipositional behavior, pollination behavior, co-evolution of plants and insect pollinators. Behaviour in IPM-Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semiochemicals, auditory stimuli and visual signals in pest management.

Unit-9: Integrated pest management

History, concept and principles of IPM. Components of IPM: Host plant resistance, agronomic manipulations, mechanical and physical methods, chemical methods, biocontrol agents utilization, genetic and behavioral control strategy etc. IPM strategies for field and horticultural crops. IPM case histories. Concept of damage levels-Economic threshold levels (ETL), Economic injury levels (EIL) and their determination. System approach, Agro ecosystem and cropping system vs. IPM. Constraints and Strategies of IPM implementation.

Principles of sampling and surveillance, database management and computer programming. simulation techniques, system analysis and modeling.

Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

Genetic engineering and new technologies-their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management-case studies; scopeand limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management. Protective cultivation, climate change and IPM, global role and risk of invasive pests.

Unit-10: Pesticide application equipment

Types of appliances: sprayers, dusters, fog generators, smoke generators, soil injecting guns, seed treating drums, flame throwers, ete. Power operated sprayers and dusters. Types of nozzles and their uses. Maintenance of appliances. Aerial application of pesticides, principles of aerial application, factors affecting the effectiveness of aerial application. Equipments for aerial applications. Advantages and disadvantages of aerial application.

Release of bio-control agents; Soil sterilization, solarization, deep ploughing, flooding,techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers: Uses of light, transmission and scanning electron microscopy: Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/ PAGE: Use of tissue culture techniques in plant protection; Computer application for predicting/ forecasting pest attack and identification.

Unit-11: Pest of field crops and their management

Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of cereals, oilseed, pulses and fibre crops, sugarcane and tobacco. Polyphagous pests: locusts, termites, hairy catepillars, cut worms and white grubs. Insect pest scenario in relation to climate change non-insect pests (mites, birds, rodents, snails, slugs) etc.

Unit-12: Pest of horticultural crops and their management

Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of vegetables, fruits and plantation crops, spices, condiments and-ornamentals Management of Forest insect pests needs to be added.

Unit-13: Pests of stored products and their management

Fundamentals of storage of grains and grain products. Storage losses, sources of infestation/infection, factors influencing losses, insect and non-insect pests, their nature of damage and control. Microflora in storage environment and their control. Storage structures, bulk storage and bag storage, their relative efficacy and demerits. Grain drying methods and aeration. Non-insect pests (rodents, birds, mites) of stored products and their control. Integrated management of storage pests.

Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses in toto vis-à-vis total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Concept of seed vault. Insecticide resistance in stored product pests and its

management; recent advances (MAS, PPP, HS) in storage pest management; Integrated approaches to stored grain pest management.

Unit-14: Arthropod vectors of plant diseases

Common arthropod vectors viz., aphids, leaf hoppers, plant hoppers, whiteflies, thrips, psylids, beetles, weevils, flies, bees and mites and their relationship with the plant pathogenic fungi, bacteria, viruses, mycoplasma. Mechanism of pathogen transmission; Active mechanical transmission, biological transmission. Toxicogenic insects, mites and phytotoxemia. Some important arthropod vector transmitted diseases and their epidemiology in India. Management of vector and its effect on control of diseases.

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect-vectors. Efficiency of transmission.

Unit-15: Honey bees and beekeeping

Honey bees and their economic importance. Bee species, their behaviour, habit and habitats.

Bee Keeping: bee pasturage, hives and equipments, seasonal management. Bee enemies including diseases and their control.

Bee genetics; Principles and procedures of bee breeding: Screening of honey bee colonies; Techniques in mass queen bee rearing, Mating nuclei and their establishment; Selective mating: Queen bee management; Bee packages.

Pesticide poisoning to honey bees, signs and protection; Protocols in evaluation of pesticide toxicity to honey bees.

Honey-composition, properties, crystallization, post-harvest handling and processing; Honey quality standards and assessment; Apicultural diversification potential and profitability; Production/ collection of bee pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling: Apitherapy: Value addition of hive products; Development of apiculture project.

Non-Apis pollinators, their augmentation and conservation; Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops.

Unit-16: Silkworms and sericulture

Silkworm species, their systematic position and salient features. Rearing techniques of mulberry-muga-eri and tassar silkworms. Nutritional requirements of silkworms. Sericulture: rearing house and appliances, silkworm breeds, principles of voltism and moultism, seed production and its economics. Enemies and diseases of silkworms and their management. Sericulture organization in India.

History of Sericulture, importance, distribution, area and silk production Morphology and biology of silkworm, sex limited characters, anatomy of digestive and excretory systems of larva; structure and function of silk glands.

Post cocoon technology, stifling, cocoon cooking, brushing, reeling, re-reeling, bleaching, degumming, dyeing, printing and weaving, different reeling machines; value addition in sericulture, economics of sericulture.

Unit-17: Lac Insect

Lac insect, its biology, habit and habitats. Host Trees: pruning, inoculation, lac cropping techniques and harvesting. Enemies of lac insect and their control.

History of lac production; importance, potential of lac production in India, Organizations involved in lac production activities; Strains of lac insects and lac crops-distribution, area and production of different strains of lac.

Introduction, lac insect-host plant interaction; Selection of brood lac, local practices, improved alternatives, coupe system; propagation of lac insects; Natural self inoculation, artificial inoculation; inoculation process and duration; removal of phunki, harvesting of lac, immature harvesting, mature harvesting and time of harvesting. Predators and parasitoids of lac insect, hyperparasites, diseases and their management.

Lac production stages; factors affecting yield and quality of shellac. Pure stock of host plants (kusum, palas, ber, pigeonpea, semialata); alternative method, technology of broodpreserving. Host-specific technologie-cultivation on specific host plants; integration of lac cultivation with agro-forestry and horticulture, socio-economic potential of lac; export-import of lac/ lac products; marketing of lac and its products. Lac processing and value addition; entrepreneurship development.

Other useful insects

Pollinators, biocontrol agents of weeds, soil fertility improving agents, scavengers. Usc of insects and insect products in medicines. Usefulness of insects in scientific investigations, insects as food.

Edible and therapeutic insects: the concept, definition, and importance. History and origin of insects as food, feed and medication; important insect species and insect products consumed.

Edible insect ecology, conservation and management of edible insect resources; environmental opportunities of insect rearing. Nutritional composition and role of insects in food security. Unit V Insect farming: the concept, definitions, and rearing techniques. Processing edible insects for food and feed. Food safety and preservation, edible insects for livelihood security Introduction to medical, veterinary and forensic entomology, Classification of Arthropod- borne diseases; Hematophagy, disease transmission and epidemiology, flies (Diptera) of medical and veterinary Importance; moth flies: Leishmaniasis and Bartonellosis, biting midges (Ceratapogonidae), Mosquito taxonomy, biology, and behavior, mosquito viruses: EEE, VEE, SLE, yellow fever. Mosquito surveillance; malaria; horse flies, deer flies: EIA, anaplasmosis, muscid flies, Myiasis (Muscoidea); myiasis and louse flies, black flies of medical and veterinary Importance, filariasis; mansonellosis, onchocerciasis. Lice of medical and veterinary importance; rickettsial diseases: epidemic typhus, etc.mites:; rickettsial pox; mites and acariasis: mange, scabies, chiggers, spiders and scorpions, fleas (Siphonaptera) of medical and veterinary importance, plague and murine typhus. Ticks of medical and veterinary importance: lyme disease, rocky mountain spotted fever, tularemia, true bugs (Hemiptera): kissing bugs and bedbugs, chagas disease; tsetse flies; Lepidoptera and Hymenoptera of medical and veterinary importance.

Introduction to forestry in the tropics, tropical forests: characteristics and types of tropical forests, management of tropical forests and the problems in their management; plantation forestry: beginnings. expansion and current status. History of tropical forest entomology, diversity of forest insects: structural and functional diversity the feeding guilds, concept of pests, ecology of insects in forest environment, concept and functioning of ecosystem, role of insects in ecosystem processes of tropical forests: insects as primary consumers, secondary and tertiary consumers, as decomposers, as food, pollinators and other ecologicalinteractions. Insect pests in natural forests, general pest incidence, pest outbreaks: Lepidoptera, Coleoptera, Hemiptera, and Hymenoptera; insect pests in plantations, nursery pests, sapling pests, pests of older plantations and their impact; insect pests of stored timber, categories of wood destroying insects and their damage: termites and beetles. Population dynamics, characteristics of population growth, factors affection population growth, principles governing population dynamics, types and causes of forest insect outbreaks: general issues in forest entomology: enemies hypothesis, resource concentration hypothesis, pest evolution hypothesis; pest problems in plantations of indigenous vs exotic species, pest problems in monocultures vs mixed plantations. Management of tropical forest insect pests, historical development and present status of tropical forest pest management, overview of pest management options: preventive measures, remedial measures; unique features of forest pest management, constraints to forest pest management in the tropics, guidelines for the practice of forest pest management in the tropics. Insect pests in plantations: Location- specific case studies.

Unit-18: Statistics and computer application

Frequency distribution, mean, mode and median. Standard, normal, bionomial and Poisson's distribution, Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi-square, Duncan's multiple range tests. Design of experiments. Principles of Randomized block design, Completely randomized block design, Latin square design, Split-plot designs Probit analysis. Use of soft ware packages like SPSS, SAS, etc. for the above tests and designs of experiments for analysis.

Nematology

Unit-1: History and Principles of Plant Pathology

Diseases caused by plant-parasitic nematodes-symptomatology, biology, distribution and management of plant parasitic nematodes of economic importance (Pratylenchus, Radopholus, Hirschmanniella, Meloidogyne, Heterodera, Globodera, Rotylenchulus. Tylenchulus, Ditylenchus, Anguina, Aphelenchoides, Tylenchorhynchus, Helicotylenchus, Hoplolaimus, Scutellonema, Paratylenchus, etc.). Entomopathogenic nematodes

Unit-2: Laboratory and Analytical Techniques

Principles and concepts of taxonomy. Rules of nomenclature. Nematode phylogeny and systematics. Classification of soil and plant -parasitic nematodes and their relationships with other related phyla. Detailed classification of plant parasitic nematodes up to generic level with emphasis on genera of economic importance. General morphology and anatomy of nematodes. Various systems: digestive, excretory, nervous, reproductive etc., developmental biology of nematodes.

Unit-3: Physiological and Molecular Plant Pathology

Methods of extraction of nematodes from soil and plant material. Microscopy -principles and types including electron microscopes. Methods of killing, fixing, preserving, staining. mounting and measuring of nematodes. Techniques for histopathology and culturing of nematodes plant parasitic, entomophilic and saprophytic including axenic methods. Experimental techniques for proving pathogenicity, estimation of crop losses, nematicide screening, screening and evaluation for nematode resistance in crops. Molecular technique for nematode diagnostics. Techniques for mass culturing of nematode antagonistic bioagents.

Unit-4: Nematode Ecology

Ecological classification and distribution of nematodes. Mode of nematode dispersal. Adaptations to parasite mode of life. Soil as environment for nematodes. Effect of biotic and abiotic factors on nematode survival, activity and reproduction. Nematode population dynamics. Nematode -induced plant damage and modeling. Community analysis.

Unit-5: Plant Nematode Relationships

Types of parasitism in nematodes. Nature of damage caused by various groups of plant parasitic nematodes and mechanisms involved. Pathotypes in nematodes. Mechanism of nematode resistance and tolerance in plants and its assessment. Physiological, biochemical and molecular changes in plants due to nematode infections. Physiological, biochemical and molecular changes in plants due to nematode infections is covered in Ph.D..

Unit-6: Nematode Physiology and Cytology

Chemical composition of nematodes. Principles of nematode physiology. Physiological functions of cell; organelles. Physiology of respiration, digestion, excretion, reproduction, growth and development. Physiology of muscular, nervous and sensory responses. Physiology of moulting. hatching and nematode survival. Chemoreception in nematodes. Nematode as biological models Caenorhabditis elegans. Cytological changes in plants due to infection including syncytia, giant cell formation and their modification etc.

Unit-7: Nematode Management Principles and methods of nematode management physical, cultural biological, chemical and legislative, Nematicides (including those of biological origin) history, classification, formulations, application and mode of action. Host resistance for nematode management. Integrated nematode management. Role of biotechnology in nematode management.

Unit-8: Interactions of Nematodes with Soil Organisms Importance of interactions (interrelationships) of nematodes with soil organisms. Interactions of nematodes with bacteria, fungi, viruses, mycorhizae and other nematodes. Nematodes as vectors of viruses and other microorganisms.

Unit-9: Statistics

Frequency distribution. Measures of central tendency and dispersion: mean, median, mode, standard deviation etc. Population distributions: normal, binomial and poisson. Correlations: partial and multiple. Tests of significance: t, F and Chi square and randomized block, Latin square and split plot designs, their analysis and interpretation.

Plant Pathology

Unit-1: History and Principles of Plant Pathology

Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical development of chemicals, legislative, cultural and biological protection measures including classification of plant diseases Physiologic specialization, Koch's postulates. Growth, reproduction, survival and dispersal of plant pathogens. Factors influencing infection, colonization and development of symptoms.

Unit-2: Laboratory and Analytical Techniques

Preparation and sterilization of common media. Methods of isolation of pathogens and their identification. Preservation of microorganisms in pure culture. Methods of inoculation. Measurement of plant disease. Molecular detection of pathogens in seeds and other planting materials: Nucleic acid probes, Southern, Northern and Western hybridization, ELISA, ISEM and PCR. Laboratory equipment and their use: autoclave, hot air oven, laminar flow, spectrophotometer, electrophoresis, light and electron microscopy, incubator, ultracentrifuge, ELISA Reader,PCR and Non-PCR based high-throughput diagnostic techniques, Genotypic tools such as genome/ specific gene sequence homology comparison by BLAST (NCBI and EMBL), whole genome sequencing; Volatile compounds profiling by using GC-MS and LC-MS; FAME analysis, Fluorescence in-situ Hybridization (FISH), Flow Cytometry, Phage display technique, biosensors for detection of plant pathogens

Unit-3: Physiological and Molecular Plant Pathology

Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: recognition phenomenon, penetration, invasion, primary disease determinant. Enzymes and toxins in relation to plant disease. Mechanisms of resistance. Phytoalexins. PR proteins. Antiviral proteins. SAR. HR and active oxygen radicals. Tissue culture. Somaclonal variation and somatic hybridization. Elementary genetic engineering. Management of pathogens through satellite, antisense RNA. Ribozymes, coat protein, hypovirulence cross protection/useful genes and promoter technology biosafety and bioethics. 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection.

History of host plant resistance and importance to Agriculture. Importance and role of biotechnological tools in plant pathology. Basic concepts and principles to study host pathogen, relationship. Molecular genetics, imaging and analytical chemistry tools for studying plants, microbes, and their interactions. Different forms of plant-microbe interactions and nature of signals effectors underpinning these interactions. Plant innate immunity: PAMP/ DAMP. Molecular basis of host-pathogen interaction-fungi, bacteria, viruses and nematodes; recognition system, signal transduction, virus induced gene silencing, Molecular basis of gene-for-gene hypothesis, R-gene expression and transcription profiling, mapping and cloning of resistance genes, Gene for gene systems molecular mechanisms, Co-evolution-arms race and trench warfare models, Metapopulations, cost of resistance, cost of unnecessary virulence, durability of resistance, erosionof quantitative resistance. Pathogen population genetics.

Unit-4: Mycology

Classification of fungi, Economic mycology, edible fungi and entomogenous fungi. Mycorrhizal associations. Cell organelles, their morphology, functions and chemical composition serological, chemical molecular and numerical taxonomy. Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of funga imperfecti. sex hormones in fungi, pleomorphism and speciation in fungi. Mechanism of nuclear and extra-nuclear inheritance, biodegradation, genetic improvement of fungal strains, fungi mediated synthesis of nano particles - characterization process and application, mycotoxins problems and its management.

Unit-5: Plant Bacteriology

Identification and classification of bacteria, morphology, ultrastructure and chemical composition of prokaryotic cell in relation to function. Growth curve, nutrition and auxotrophic mutants. Resting cells in prokaryotic, elementary bacterial genetics and variability: transformation, conjugation, transduction. Biology of extra chromosomal elements: plasmid borne genes and their expression: ar, her, vie and pat genes. Bacteriophages: lytic and lysogenic cycles. Prokaryotic inhibitors and their mode of action, Economic uses of prokaryotes. Morphology, biochemical characteristics, reproduction and life cycle of phytoplasma and other fastidious prokaryotes. Spiroplasmas and Phytoplasmas, role of virulence factors in expression of symptoms, Variability among phytopathogenic prokarya, L. form of bacteria Advances in classification and nomenclature, specialized mechanisms of variability. Transposable genetic elements in bacteria-integron and prophages, pathogenicity islands, bacterial Pan-Genome. Qurum sensing, Bacterial pathogenicity and virulence, bacterial secretion systems, Role of hrp/hrc genes and TALE effectors. Synthesis and regulation of EPSs, beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Unit-6: Plant Virology

Nature, composition and architecture of viruses and viroids. Properties of viruses. Variability in viruses. Satellite viruses and satellite RNA Assay of plant viruses including biological, physical, chemical, serological and molecular methods Conventional and biotechnological techniques used in detection and diagnosis. Rehaviour of vinoes in plants including infection, replication and movement. Histopathological changes induced by viruses in plants, inclusion bodies. Transmission of viruses: virus - vector relationships. Nomenclature and classification of viruses Gene expression, regulation and viral promoters. Genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes Virus potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture for production of virus free planting materials, virus genome organization replication, transcription and translational strategies, Phylogenetic grouping system based on partial/complete sequences of virus genomes and using of next generation sequencing technology in plant virus discovery. Classification, structure and functions of various domains of Immunoglobulins. Production of polyclonal and monoclonal antibodies for detection of viruses.

Unit-7: Plant Disease Epidemiology

Concepts in epidemiology Development of disease in plant population. Monocyclic and polycyclic pathogens. Role of environment and meteorological factors in the development of plant disease epidemics. Survey, surveillance (including through remote sensing), and prediction and forecasting of diseases. Epidemic analysis and prediction models. Crop loss assessment critical and multiple point models. Elements of epidemics and their interaction Structures and patterns of epidemics, expert systems in plant pathology. Genetics of epidemics Models

development of plant disease epidemics. Common and natural logarithms, function fitting, area under disease progress curve and correction factors, inoculum dynamics, image analysis.

Unit-8: Phanerogamic parasites and Non-Parasitic Diseases

Diseases caused by Phanerogamic parasites and their management. Diseases due to unfavourablesoil environment, drought and flooding stress etc. Nutritional deficiencies. Primary /secondary airpollutants and acid rain.

Unit-9: Fungal Diseases of Crop Plants

Fungal diseases of cereals, millets, oilseeds, pulses, fruits, vegetables, plantation, fiber, spices and ornamental crops with special reference to etiology, disease cycle, perpatuation, epidemiology and management. Post harvest diseases in transit and storage, aflatoxins and their integrated management. Diseases of cash crops, fodder legume crops, Medicinal crops

Unit-10: Bacterial and Viral Diseases of Crop Plants

Crop diseases of cereals, pulses, oilseeds, vegetables, fruits, plantation and fiber crops caused by bacteria, viruses, viroids, phytoplasmas and other fastidious prokaryotes. Mode of transmission and pathogen vector relationships. Epidemiology and management. Diseases of cash crops, fodder legume crops, Medicinal crops.

Unit-11: Management of Plant Diseases

General principles of plant quarantine. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Genetic basis of disease resistance and pathogenicity: gene for gene hyphothesis; parasite mediated frequency dependent selection concept of QTL mapping: breeding for discase resistance. Production of disease free seeds and planting materials. Seed certification. Chemical nature and classification of fungicides and antibiotics their bioassay and compatibility with other agricultural chemicals; resistance to fungicides/antibiotics; effect on environment. Spraying and dusting equipments, their care and maintenances. Important cultural practices and their role in disease management, solarization, integrated disease management. Microorganisms antagonistic to plantpathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases; soil fungistasis. Plant growth promoting Rhizobacteria. Types of resistance disease escape, disease tolerance, hypersensitivity mechanisms, protein-for-protein and immunization basis, management of resistance genes, phytotoxicity of fungicides, persistence, composite formulations of pesticides, issues related to label claim, mode of action and application of different chemicals, residues and health hazards, Important botanicals used against diseases and their mode of action. Types of losses caused by seed-borne diseases in true and vegetative propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens, Management of seed-borne pathogens, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents. Gene editing, role of ISTA, EPPO, OECD, etc, in certification and quality control. National Regulatory mechanism and certification, system including seed certification, minimum seed certification standards, role of seed/ planting material health certification in national and international trade. National Regulatory Mechanism and International Agreements/ Conventions, viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures, Biosafety, policies and regulatory mechanism.

Agronomy

Unit-1: Current Trends in Agronomy

Agro-physiological basis of variation in yield, globalization of agriculture and WTO, precision farming, protected agriculture; contract farming; organic farming, conservation agriculture; soil-less cultivation; acroponics, hydroponics, vertical farming and terrace farming; use of GIS, GPS, remote sensing and robotics for crop management in modern agriculture, use of block chain and big data analysis; contract farming; mechanization in crop cultivation systems; global warming and crop productivity, GM crops, GM seed production technology, seed certification, seed multiplication, hybrid seed production etc.. concepts of system agriculture; holistic approach of farming systems, artificial intelligence-concept and application.

Unit-2: Recent Trends in Crop Growth and Productivity

Geo-ecological zones of India; crop growth analysis in relation to environment, capacity and intensity factors of plant growth; factors influencing vegetative (thermophase) and reproductive (photophase) of plants/crops, quantitative agro-biological principles and inverse yieid nitrogen law, Mitscherlich's yield equation, its interpretation and applicability, Baule Unit; optimization of plant density and planting geometry in relation to different resources, concept of ideal plant type and crep modeling for desired crop yield; strategies for maximizing solar energy utilization; leaf area interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; solar radiation concept and agro-techniques for harvesting solar radiation; growth analysis: CGR, RGR, NAR, LAI, LAD, LAR-concept, relevance, critical values; validity and limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems, root-shoot relationship; yield and environmental stress, use of growth hormones and regulators for better adaptation in stressed condition: heat Unit concept of crop maturity: concept and types of heat Units, concept of plant videotapes: crop physiological and new ideotypes: characteristics of videotape for wheat, rice, maize, etc:

Unit-3: Soil Fertility and Nutrient Management

Factors affecting soil fertility and productivity, problems of supply and availability of nutrients; relation between nutrient supply and crop growth; criteria of essentiality of nutrients, essential plant nutrients and their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients; commercial fertilizers, composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency; agronomic, chemical and physiological, fertilizer mixtures and grades, nano-fertilizer materials, methods of increasing fertilizer use efficiency, nutrientinteractions; time and methods of manures and fertilizers application; different approaches of fertilizers/ nutrients recommendations in crops and cropping systems, nutrient

management sensors/gadgets, foliar application and its concept; relative performance of organic and inorganic nutrients; economics of fertilizer use; use of vermicompost and residue wastes in crops, integrated nutrient management;

Unit-4: Water and Irrigation Management

Global water resources; water resources of India, irrigation projects during pre and post- independence period and their significance in crop production; field water cycle, water movement in soil and plants; soil-water-plant relationships, SPAC; soil and plant water potential; water absorption by plants; crop water stress-water deficits and crop growth; plant response to water stress, crop plant adaptation to moisture stress condition; irrigation needs; meteorological, soil, agronomic and plant factors affecting irrigation need; water deficits and crop growth; water movement in soil under saturated and unsaturated conditions; Poiseulle's and Darcy's law; general equation of saturated and unsaturated flow of water in soil; runoff and infiltration reciprocity, evaporation, transpiration and evapotranspiration, significance of transpiration; energy utilization in transpiration; water requirement of crop plants, water/irrigation needs, water use efficiency, management practices for improving water use efficiency of crops; factors affecting ET, control of ET by mulching and use of anti-transpirent; interaction between irrigation and fertilizers; fertilizer use in relation to irrigation; water availability in relation to nutrient availability, scheduling, depth and methods of irrigation; micro irrigation systems; deficit irrigation; fertigation, management of water in controlled environments and polyhouses; application of irrigation water, conveyance and distribution system, various irrigation efficiencies; agronomic considerations in the designand operation of irrigation projects; field water budget (water gain and loss at crop rootzone); characteristics of irrigation and farming systems affecting irrigation management; automated irrigation systems; strategics of using limited water supply; water harvesting, rain water management and its utilization for crop production; hydroponics, water management of crops under climate change scenario; optimizing the use of given irrigation supplies, land suitability for irrigation, water quality; land irrigability classification, integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation, economic analysis of irrigation and cop planning for optimum use of irrigation water in command areas; use of models for water management

Unit-5: Recent Trends in Weed Management

Weed biology, ecology, and classification; crop-weed competition, interference and allelopathy, weed shift in different eco-systems causes and effects; principles and methods of weed control; weed control indices, weed management in major crops and croppingsystems: alien, invasive and parasitic weeds and their management; migration, introduction and adaptation of weeds; mvasive weeds biology and management; different mechanisms of invasion present status and factors influencing weed invasion; herbicides: introduction, history classification

based on miscellany, chemistry, physiological biochemical actions, herbicide structure-activity relationship, factors affecting the efficiency of herbicides; herbicides absorption, translocation, metabolism and mode and mechanism of action; activity and selectivity and factors affecting them; herbicide formulations, herbicide mixtures and rotation, sequential herbicides application: herbicides compatibility; climatic factors and phytotoxicity of herbicides; Transformation/fate of herbicides in plant and soil and factors affecting them, residue management of herbicides; primary and secondary metabolites. adjuvants; trends in new herbicide products/molecules, application techniques and methods; herbicide resistance in weeds and management; antidotes and crop protection; compatibility of herbicides with other pesticides; development of transgenic herbicide tolerant crops: herbicide development and registration procedures; relationship of herbicides with tillage, fertilizer, irrigation and cropping system; bioherbicides and allelochemical, herbicide bioassays and chemical methods for residue analysis; recent advances in nonchemical weed management including deleterious rhizobacteria, biodegradable film, flaming, etc.; recent development in weed management; use of robotics, drones and aeroplanes, weed problems in organic production systems, organic herbicides; integrated weed management for inorganic and organic production systems.;

Unit-6: Conservation Agriculture

Conservation agriculture (CA), principles, prospects and importance; advantages & disadvantages; conventional and conservation agriculture systems, sustainability concerns.

conservation agriculture concept, historical background, global experiences, present status in India; similarity/dissimilarity between resource conservation technology (RCT) and CA; similarity/dissimilarity between conservation tillage and CA; modern concept of tillage and us management conservation agriculture: nutrient management, water management, weed dynamics & management, energy use, resource and input-use efficiency, insect pest and disease dynamics & management, farm machinery, crop residue management, cover crop management: C-sequestration, soil health: physical, chemical and biological properties of soils; climate change adaptation and mitigation potential of CA and potential benefits; CA in agroforestry systems and rainfed/dryland regions, economic considerations and adoption of CA; constraints and future of agriculture under CA; policy issues.

Unit-7: Cropping Systems and Sustainable Agriculture

Major cropping systems of irrigated, rainfed/dry land and semi-arid/arid environments and their approximate acreage in India; Resources capture and use efficiency, soil and water management in cropping systems; assessment of land use; concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and

intercropping; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria inassessing the yield advantages; competitive relationship and competition functions; biologicaland agronomic basis of yield advantage under intercropping; mechanism of yield advantage in intercropping systems; above and below ground interactions and allelopathic effects; competition relations; cropping patterns, alternate land use and crop diversification in rainfed and irrigated conditions, multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture; crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system, advanced nutritional tools for big data analysis and interpretation; plant ideotypes for drylands, plant growth regulators and their role in sustainability.

Unit-8: Dryland Farming and Watershed Management

Concept and characteristics of dry land farming, dry land versus rainfed farming, significance and dimensions of dry land farming in Indian agriculture, soil properties and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, physiological principles of dry land crop production, constraints and remedial measures; characterization of environment for water availability, crop planning for erratic and aberrant weather conditions, stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies: management and breeding strategies to improve crop productivity under different patterns of drought situation under limited water supplies, preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions; tillage, tilth, frequency and depth of cultivation, compaction in soil tillage, concept of conservation tillage; modernconcept of tillage in relation to weed control and moisture conservation, techniques and practices of soil moisture conservation, use of mulches, kinds, effectiveness and economics; anti- transpirants; soil and crop management techniques, seeding and efficient fertilizer use, concept of watershed resource management, problems, approach and components

Unit-9: Integrated Farming Systems and Sustainable Agriculture

Integrated farming systems, scope and importance: classification of IFS based on enterprises as well as under rainfed/irrigated condition in different land situation; farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply and enterprises; concept of sustainability of integrated farming systems; sustainability parameters and indicators; efficient integrated farming systems based on economic viability and natural resources identification and management; production potential of different components of integrated farming systems; interaction and mechanism of differentproduction factors; stability of integrated farming system based on research/long term information in different systems through research; eco-physiological approaches to

intereropping, integration of components and adaptability of different farming system based on land situations and climatic condition of a region; agro-forestry systems; evaluation of different IFS models; simulation models for intercropping, soil nutrient in intereropping: formation of different IFS Models, recycling of organic waste in IFS; new concepts and approaches of farming system and organic farming, alternate land use system; value addition, waste recycling, quantification and mitigation of green-house gasses; possible use of ITKs in integrated farming system.

Unit-10: Soil Conservation and Watershed Management

Soil conservation; methods of soil conservation; soil crosion, nature and extent of erosion; types of erosion, factors affecting erosion, agronomic measures contour cultivation, strip cropping, cover crops, mulching, tillage, cropping system vegetative barriers; improved dry farming practices, mechanical measures bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts, watershed management: objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas, drainage, methods of drainage, drainage considerations and agronomic management; land use capability classification, alternate land use systems; agro-forestry; ley farming, jhum management - basic concepts, socio-ethnic aspects, its layout; rehabilitation of abandoned jhum lands and measures to prevent soil erosion.

Unit-11: Principles and Practices of Organic Farming

Organic farming (OF) concepts, its relevance to india and global agriculture and future prospects; productivity and sustainability issues, principles of organic agriculture; selection and conversion of land, soil and water management land usc, role of conservation tillage; shelter zones, hedges, pasture management, agro-forestry organic farming: water use efficiency, soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, methods for enrichment of crop residues with minerals, micronutrients and its fortification, earthworms and vermicompost; green manures, bio-fertilizers and biogas technology; preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates, their composition, availability and crop responses; recycling of organic wastes and residue management, organic farming systems - selection of crops and crop rotations, multiple and relay cropping systems. intercropping in relation to maintenance of soil productivity; weed, insect pest and disease management, biological agents and pheromones, bio-pesticides botanicals for pest management, indigenous practices and their importance in plant protection; marketing and export potential of organic products; quality standards, inspection, certification, labeling and accreditation procedures, organic farming and national economy; socio-economic impacts; organic farming ITKs, carbon and energy budgeting.

Unit-12: Stress Crop Production

Stress and strain terminology, nature and stress injury and resistance; causes and mechanisms of stresses in plants; reactive oxygen species (ROS), scavenger enzymes, hormones/ growth regulators actions; mechanisms of drought tolerance; drought tolerance traits and their measurements; response of crop to acidity, salinity, sodicity, excess water and nutrient imbalances; low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature stress through soil and crop manipulations; high temperature otheat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations; water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations, excess water or flooding stress meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations, salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations; mechanical impedance of soil and its impact on plant growth; measures to evercome soil mechanical impedance; environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

Unit-13: Agronomy of Major Cereal/ Pulse/Oilseed/Fibre/Sugar Crops

Origin, history, area, production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of: rubi cereals and oilseeds rapeseed, mustard, linseed and niger): kharif cereals and oilseeds (groundnut, sesame, castor, sunflower, soybean and safflower) rabi pulses, kharif pulses, Kharif Cereais (Rice and Maize, Rabi Cereals (Wheat, Barley, Rye and Oats). Millets (Sorghum, Pearlmillet, Fingermillet and Minor Millets), Kharif pulses (Redgram, Greengram, Blackgram and Cowpea) Rabi Pulses (Bengalgram, Peas, Lentil, Lathyrus, Rajmash), Kharif Oilseeds (Groundnut, Sesamum, Castor, Sunflower, Soybean and Safflower), Rabi Oilseeds (Rapeseed, Mustard, Linseed and Niger) fibre crops (cotton, jute, ramie and mesta); sugar crops (sugar beet and sugarcane); phonological studies at different growth stages of crop, estimation of crop yield on the basis of yield attributes; formulation of cropping schemes for various farm sizes and calculation of cropping, and rotational intensities; working out growth indices (CGR, RGR, NAR, LAL, LAD, LAR, LWR, SLA, SLW etc); assessment of land use and yield advantage (rotational intensity, cropping intensity, diversity index, sustainable yield index crop equivalent

yield, land equivalent ratio, aggressively, relative crowding coefficient, competition ratio and ATERetc); determination of cost of cultivation and harvest index of different crops,

Unit-14: Agronomy of Fodder and Forage Crops

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like sorghum, maize, bajra, guar, cowpea, oats, barley, berseem, senji, Lucerne, etc., adaptation, distribution, varietal improvement, agro- techniques and quality aspects including anti-quality factors of important forage/grass crops; napier grass, Panicum, Laviuras, Cenchris, etc.; year-round fodder production and management, preservation and utilization of forage and pasture crops, principles and methods of hay and silage making, chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition, value addition of poor quality fodder, fodder production through hydroponics, azolla cultivation, economics of forage cultivation uses and seed production techniques of important fodder crops.

Unit-15: Agronomy of Medicinal, Aromatic and Under Utilized Crops

Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge, climate and soil requirements, cultural practices; yield and important constituents of aromatic plants (citronella, palmarosa, mentha, basil, lemon grass, rose, patchouli, Geranium); (mulhati,isabgol, rauwolfia, poppy, aloe vera, atavar, Stevia, safed musli, kalmegh, Asaphoetida, nuxvomica, rosadle, etc); climate and soil requirements; cultural practices, yield of under- utilized crops (rice bean. lathyrus, sesbania, clusterbean, frenchbean, fenugreek, grain amaranth, coffee, tea and tobacco); post-harvest handling-drawing, processing, grading, packing and storage, value addition and quality standards in herbal products; quality characters in medicinal and aromatic plants; methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants.

Unit-16: Agrostology and Agro-forestry

Agrostology: definition and importance, principles of grassland ecology: grassland ecology - commUnity, climax, dominant species, succession, biotype, ecological status of grasslands in India; grass cover of India; problems and management of grasslands, importance.classification (various criteria), scope, status and research needs of pastures, pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses, Agroforestry: definition and importance; agro-forestry systems, agri-silviculture, silvi-pasture, agri-silvipasture, agri-horticulture, aqua-silviculture, alley cropping and energy plantation:

crop production technology in agro-forestry and agrostology system, silvi-pastoral system:

meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro- forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agroforestry systems; social acceptability and economic viability, nutritive value of trees, tender operation; desirable tree characteristics. Cand nutrients cycling and sequestration, and climate change adaptation and mitigation potentials of different agro-forestry systems.