

AAO online Test series tentative schedule 2026

Paper II – Subject Paper

Agriculture (Diploma Standard) Code: 431

Each title contains 100 questions in English and Tamil

Monthly Mock: Every month, first Sunday – Subject paper & second Sunday - GS

S. No.	Unit title	No. of Question sets	Total No. of Questions	Date of assignment
1.	Unit I: Agronomic Principles, Practices and Meteorology (30 Questions)	20	2000	25-07-2026
2.	Unit II: Farming System, Dry Farming and Agro-Forestry	10	1000	01-08-2026
3.	Unit III: Soils and Fertility Management (30 Questions)	10	1000	01-08-2026
4.	Unit IV: Horticultural Crop Cultivation Techniques (10 Questions)	20	2000	08-08-2026
5.	Unit V: Breeding and Seed Production (20 Questions)	20	2000	15-08-2026
6.	Unit VI: Plant Protection Principles and Practices (30 Questions)	20	2000	22-08-2026
7.	Unit VII: Livestock, Poultry Management, Artificial Insemination and Calf Rearing (10 Questions)	15	1500	29-08-2026
8.	Unit VIII: Farm Machinery, Post-Harvest Technology and Energy and Environment (10 Questions)	10	1000	29-08-2026
9.	Unit IX: Commercial Agriculture (20 Questions)	25	2500	05-09-2026
10.	Unit X: Agricultural Extension, Agricultural Economics and Digital Agriculture (30 Questions)	25	2500	12-09-2026
10 Units		175	17500	

Unit I: Agronomic Principles, Practices and Meteorology (30 Questions) (20 Question sets)

1. Definition and Branches of Agriculture

- Scope of Agriculture; Agronomy as a core branch.
- Classification of other branches (Horticulture, Plant Breeding, Soil Science, Entomology, Pathology, Agricultural Engineering, etc.).

2. Crop Classification and Status in Tamil Nadu

- Basis of crop classification (Botanical, Agronomic, Seasonal).
- Major crops (cereals, millets, pulses, oilseeds, commercial crops) and their area, production, and productivity status in Tamil Nadu.

3. Factors Affecting Crop Production

- Climatic factors (Rainfall, Temperature, Light, Wind).
- Edaphic (Soil) factors, Biotic factors (Pests, Diseases, Weeds), and Physiographic factors.
- Socio-economic factors influencing modern agriculture.

4. Cropping Systems and Intercropping

- Definitions and principles of cropping systems.
- Types of cropping systems (Monocropping, Multiple cropping, Relay cropping).
- Intercropping: Definition, types (Row, Strip, Mixed), and advantages.

5. Tillage and Land Preparation

- Definition, objectives, and types of tillage (Primary and Secondary tillage).
- Modern concepts (Minimum tillage, Zero tillage, Conservation tillage).
- Implements and tools used for primary and secondary tillage.

6. Intercultural Operations and Crop Growth Stages

- Intercultural operations: Weeding, Hoeing, Earthing up, Gap filling, Thinning.
- Growth stages of crops (e.g., Germination, Tillering, Booting, Flowering, Maturity).

- Methods of yield estimation and prediction (Crop cutting experiments, SPAD/NDVI sensors).

7. Agricultural Meteorology and Atmosphere

- Definition, scope, and importance of meteorology in crop production.
- Composition of the atmosphere (Gases, Water vapor, Particulates) and its functions.
- Vertical layers of the atmosphere (Troposphere, Stratosphere, etc.) and their relevance to agriculture.

8. Weather Parameters and Their Role in Crop Production

- Detailed study of weather variables:
 - Solar radiation (PAR), Temperature (GDD), Humidity (VPD).
 - Wind velocity (Evapotranspiration, Lodging) and Rainfall.

9. Rainfall Variability and Agro-Climatic Zones of Tamil Nadu

- Spatial and temporal distribution of rainfall across North-East, South-West, and Winter monsoons in Tamil Nadu.
- Delineation of Agro-Climatic Zones of Tamil Nadu (e.g., Cauvery Delta, North-Eastern, Western, Southern) and their specific cropping patterns.

10. Automatic Weather Stations (AWS) and Agro-Advisory Services

- Components of AWS (Sensors for rain, temperature, humidity, wind speed, solar radiation).
- Data transmission and utilization.
- Agro-advisory services: Generation of district/state-level weather-based crop advisories for farmers.

11. Soil-Water-Plant Relationships and Moisture Constants

- Movement of water in soil (Infiltration, Percolation, Capillary rise).
- Soil moisture constants: Field Capacity, Permanent Wilting Point, Saturation.
- Calculation of Available Soil Moisture and its management.

12. Water Stress, Use Efficiency, and Critical Stages

- Effect of water stress at different physiological stages on crop yield.

- Water Use Efficiency (WUE) and Crop Water Requirement (CWR) for major crops (Paddy, Sugarcane, Cotton, Maize).
- Critical stages of water requirement for different crops.

13. Irrigation Scheduling and Methods

- Principles of irrigation scheduling (based on soil moisture, climatological approach, plant indicators).
- Types of irrigation methods:
 - Surface (Flood, Furrow, Border).
 - Overhead (Sprinkler).
 - Micro-irrigation (Drip, Micro-sprinkler).

14. Irrigation Policies and Poor-Quality Water Management

- Flagship schemes and policies of Tamil Nadu (e.g., Tamil Nadu Irrigation Infrastructure Development Fund - TNIIIDF, Kudimaramathu).
- Management of poor-quality irrigation water (Salinity, SAR management, Leaching requirements).
- Irrigation Water Use Efficiency (IWUE).

15. Soil Erosion and Conservation

- Soil erosion due to water (Sheet, Rill, Gully erosion).
- Factors affecting erosion.
- Mechanical and agronomical control measures (Contour bunding, Terracing, Mulching, Cover crops).

16. Weed Science: Definition, Classification, and Importance

- Definition of weeds and their economic importance (Losses vs. Utility).
- Classification of weeds based on Life cycle (Annual, Biennial, Perennial), Morphology (Grasses, Sedges, Broad-leaved), and Ecology (Aquatic, Terrestrial).

17. Methods of Weed Management

- Preventative, Cultural (Land preparation, Crop rotation), Mechanical (Tillage, Hand weeding), and Biological methods.

- Integrated Weed Management (IWM): Concepts, principles, and practical integration of all methods.

18. Herbicides: Classification and Application

- Herbicide classification based on Mode of Action (e.g., ACCase inhibitors, ALS inhibitors, PSII inhibitors).
- Classification based on Time of application (Pre-plant, Pre-emergence, Post-emergence).
- Application methods (Spraying, Granular application) and sprayer calibration.
- Common and new herbicides available in the Indian/Tamil Nadu market.

19. Specialized Weed Management

- Management of parasitic weeds (*Striga*, *Orobancha*), problematic weeds (*Cyperus*, *Parthenium*, *Eichhornia*), and aquatic weeds.
- Weed control practices specific to major crops (Rice, Sugarcane, Cotton, Pulses, Oilseeds).

20. Production Technologies of Major Field Crops

(A consolidated heading covering agronomic practices for all crop categories listed)

- **Cereals:** Paddy, Maize, Sorghum.
- **Millets:** Pearl Millet (Bajra), Finger Millet (Ragi), Foxtail Millet.
- **Pulses:** Red gram, Black gram, Green gram, Bengal gram.
- **Oilseeds:** Groundnut, Sunflower, Gingelly, Castor.
- **Commercial Crops:** Sugarcane, Cotton, Tobacco.
- **Specialty Crops:** Mulberry (for sericulture), Forage crops (Fodder maize, Napier), and Green Manure crops (Sunn hemp, Dhaincha).
- *Practices covered under each crop:* Climate/Soil requirements, Varieties, Seed rate/sowing, Fertilizer (NPK + Micronutrients), Irrigation, Weed control, and Harvesting/Threshing.

Unit II: Farming system, Dry Farming and Agro-Forestry (10 Questions) (10 Question sets)

1. Integrated Farming Systems (IFS): Concepts, Models, and Components

- Definition, objectives, and importance of IFS for sustainability and risk mitigation.
- Major components (Crops, Livestock, Poultry, Fishery, Sericulture, Apiary, Mushroom, Biogas).
- IFS models for different agro-climatic zones (Irrigated, Rainfed, Coastal, Hilly).
- Flagship IFS schemes and policies of Tamil Nadu (e.g., *Chief Minister's Uzhavar Thittam, Tamil Nadu IFS Scheme*).

2. Cropping Schemes and Crop Calendars

- Difference between cropping systems and cropping schemes.
- Preparation and interpretation of a crop calendar for major crops of Tamil Nadu (Paddy, Sugarcane, Cotton, Groundnut, Millets) – detailing land preparation, sowing, fertilizer, irrigation, weed control, and harvesting windows.

3. Dry Farming: Definition, Status, and Soil Constraints

- Definition, distinguishing features, and present status of dry farming in Tamil Nadu (area, distribution, productivity).
- Soils of dry farming tracts (Red soils, Lateritic soils, Shallow black soils) and their limitations to crop production (Low moisture retention, poor fertility, crusting, erosion).

4. Dry Land Technologies for Increased Crop Productivity

- Suitable dryland technologies: Pre-monsoon sowing (dry seeding), Ridge and furrow planting, Compartmental bunding, Broad bed and furrow (BBF) systems.
- Selection of drought-tolerant varieties and crop diversification for drylands.
- Conventional crop production vs. alternate land use in drylands (Agro-horti systems, Silvi-pastoral systems).

5. Drought and Disaster Management in Agriculture

- Types of drought (Meteorological, Hydrological, Agricultural).
- Effects of drought and weather aberrations (dry spells, untimely rains) on dryland crops.
- Contingent crop planning (mid-season corrections, crop substitution, intercropping with legumes).

- Crop insurance schemes in Tamil Nadu (e.g., *Pradhan Mantri Fasal Bima Yojana - PMFBY, TN Government's free crop insurance*).

6. Soil Erosion: Classification and Soil Moisture Conservation

- Classification of erosion (Water erosion - Splash, Sheet, Rill, Gully; Wind erosion).
- Soil moisture conservation practices:
 - **Agronomical:** Mulching, Contour cultivation, Strip cropping, Cover cropping.
 - **Physical/Mechanical:** Terracing, Bunding, Trenching.
 - **Biological:** Growing vegetative barriers (Grass strips, Hedgerows).

7. Water Harvesting Structures and Watershed Development

- In-situ and ex-situ water harvesting for drylands.
- Design and utility of Farm Ponds and Percolation Ponds (recharging groundwater, supplemental irrigation).
- Watershed Development: Definition, objectives, and core components (Soil and moisture conservation, Afforestation, Pasture development, Livelihood interventions).
- Watershed-based schemes in Tamil Nadu (e.g., *IWMP - Integrated Watershed Management Programme*).

8. Land Use Classification and the Role of Forests

- Land use classification systems (Forests, Barren lands, Cultivable wastelands, Net sown area, Current/Other fallows).
- Ecological and economic role of forests in sustainable agriculture (Microclimate regulation, Soil conservation, Carbon sequestration, Fuel/Fodder supply).

9. Agroforestry: Definition, Types, and Systems

- Definition and scope of Agroforestry.
- Types: **Social Forestry** (Community woodlots, Roadside plantations), **Urban Forestry**, and **Agroforestry**.
- Agroforestry systems:
 - *Agrisilvicultural* (Crops + Trees), *Silvipastoral* (Trees + Pasture/Livestock), *Agrisilvipastoral*.
 - **Shifting Cultivation** (Jhum) – definition, issues, and alternatives.

- **Alley Cropping** (Hedgerow intercropping) – principles and benefits.
- **Windbreaks** and **Shelterbelts** – design and importance in reducing wind erosion and moisture loss.

10. Production and Management Practices of Major Agroforestry Trees

- Agronomic management (Nursery raising, Spacing, Planting seasons, Irrigation, Pruning, Thinning, Harvesting cycles) for key tree species:
 - **Teak** (*Tectona grandis*)
 - **Casuarina** (*Casuarina equisetifolia*)
 - **Ailanthus** (*Ailanthus excelsa* - used as support for betel/grape)
 - **Neem** (*Azadirachta indica*)
 - **Bamboo** (*Bambusa* spp.)
 - **Acacia** (*Acacia nilotica* / *A. auriculiformis*).

Unit III: Soils and Fertility Management (30 Questions) (10 Question sets)

1. Fundamentals of Soil Science and Soils of Tamil Nadu

- Definition of soil and its four main components (Mineral matter, Organic matter, Water, Air).
- Soil formation processes (Weathering) and factors influencing it.
- Major soil orders and their distribution in Tamil Nadu (Red soils, Black cotton soils, Lateritic soils, Coastal alluvium, River alluvium).

2. Soil Physical Properties and Their Significance

- Soil texture (Sand, Silt, Clay) and its influence on water holding capacity and drainage.
- Soil structure (Types - Granular, Blocky, Platy, Prismatic) and its effect on root penetration and aeration.
- Bulk density, Particle density, and Pore space - their roles in root growth and seedling emergence.
- Significance of Soil colour and Soil temperature in crop production.

3. Soil Chemical and Biological Properties

- Soil pH, Electrical Conductivity (EC), and Cation Exchange Capacity (CEC) - definitions and their significance in nutrient availability.
- Soil organic matter: Its composition, importance in improving soil structure, water retention, and nutrient supply (N, P, S mineralization).
- Soil microorganisms: Role of Bacteria (N-fixing, P-solubilizing), Fungi (Mycorrhizae), Actinomycetes, and Algae in nutrient cycling and soil health maintenance.

4. Problem Soils: Acid, Saline, and Alkaline (Sodic) Soils

- Characteristics and causes of soil acidity.
- Reclamation of acid soils (Liming materials - application and rates).
- Characteristics and identification of saline soils (White crust, high EC) and alkaline/sodic soils (Black crust, high pH, poor permeability).
- Reclamation methods: Chemical amendments (Gypsum, Pyrites, Sulphur) and cultural practices (Flushing, Organic matter addition, Green manuring).

5. Soil and Water Pollution Management

- Soil pollutants: Sources (Industrial effluents, Agrochemicals, Heavy metals, Plastics) and their impact on soil biota and crop quality.
- Water pollutants: Nitrate leaching, Pesticide runoff, and Eutrophication.
- Management strategies: Bioremediation, Phytoremediation, Judicious use of agrochemicals, and Safe disposal of waste.

6. Irrigation Water Quality and Testing

- Qualities of irrigation water: pH, EC, Residual Sodium Carbonate (RSC), Sodium Adsorption Ratio (SAR), and Boron content.
- Classification of irrigation water (C1-S1 to C4-S4 classes) and their suitability for different crops.
- Water testing procedures and interpretation of irrigation water analysis reports.

7. Soil Fertility and Plant Nutrients

- Definition of soil fertility vs. soil productivity.
- Classification of essential plant nutrients:
 - **Major/Macronutrients:** Nitrogen (N), Phosphorus (P), Potassium (K).

- **Secondary nutrients:** Calcium (Ca), Magnesium (Mg), Sulphur (S).
- **Micronutrients:** Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), Boron (B), Molybdenum (Mo), Chlorine (Cl), Nickel (Ni).
- Functions of each nutrient in plant metabolism.

8. Nutrient Deficiency Symptoms and Management

- Identification of deficiency symptoms of major, secondary, and micro-nutrients in plants (e.g., N - chlorosis of older leaves; P - purpling; K - scorching of margins; Zn - white bud/mottled leaf; Fe - interveinal chlorosis on young leaves).
- Differential diagnosis between deficiency and toxicity/nematode damage.
- Remedial management through soil/foliar application of deficient nutrients.
- **Soil Health Card:** Objectives, preparation, and interpretation for site-specific fertilizer recommendations.

9. Fertilizers: Types, Efficient Use, and Recommendations

- **Nitrogenous Fertilizers:** Urea, Ammonium sulphate, CAN - properties, transformations, and losses.
- **Phosphatic Fertilizers:** Single Super Phosphate (SSP), DAP, Rock phosphate - fixation and availability.
- **Potassic Fertilizers:** Muriate of Potash (MOP), Sulphate of Potash (SOP).
- **Complex and Mixed Fertilizers:** NPK grades (e.g., 17:17:17, 10:26:26, 19:19:19) and their advantages.
- Efficient fertilizer use: 4R Nutrient Stewardship (Right source, Right rate, Right time, Right place), Deep placement, Split application, Fertigation.
- Fertilizer scheduling for major crops (Paddy, Sugarcane, Cotton, Millets, Pulses).

10. Modern Tools, Biostimulants, and Biofertilizers

- **Biostimulants and New-age fertilizers:** Definitions, examples (Seaweed extracts, Humic/Fulvic acids, Protein hydrolysates), and their role as "Crop Boosters" in enhancing stress tolerance and nutrient uptake.
- **Remote Sensing, GIS, and GPS in nutrient management:** Use of drones/satellites for diagnosing nutrient stress (NDVI mapping) and Variable Rate Technology (VRT) for precision fertilizer application.

- **Biofertilizers:**

- **Groups:** Bacterial (*Rhizobium*, *Azospirillum*, *Azotobacter*, *PSB*), Fungal (VAM - *Glomus*), Algal (Blue Green Algae), and Fern (*Azolla* - as dual crop and N-biofertilizer).
- Mass production, carrier-based inoculation, and field application methods.

Unit IV: Horticultural Crop Cultivation Techniques (10 Questions) (20 Question sets)

1. Status and Scope of Horticulture in Tamil Nadu

- Area, production, productivity, and export potential of major horticultural crops in Tamil Nadu.
- Role of horticulture in nutritional security, employment generation, and doubling farmer income.
- Key horticultural schemes and missions in Tamil Nadu (e.g., *Tamil Nadu Horticultural Development Mission - TNHDM, NHM*).

2. Propagation Methods in Horticultural Crops

- Sexual propagation (Seed propagation) – advantages and limitations.
- Asexual/Vegetative propagation:
 - Natural methods (Bulbs, Corms, Rhizomes, Runners, Suckers).
 - Artificial methods (Cutting, Layering - Air layering, Ground layering, Grafting - Veneer, Side, Wedge, Budding - T-budding, Patch budding).
- Role of Plant Growth Regulators (PGRs - Auxins, Gibberellins, Cytokinins) in rooting and bud induction.

3. Major Fruit Crops of Tamil Nadu (Part I - Tropical & Subtropical)

- Production technologies (Climate/Soil, Varieties/Hybrids, Planting, Nutrient management, Irrigation, Pruning/training, Harvesting, Post-harvest) for:
 - **Mango, Banana, Papaya, Sapota, Guava, Citrus** (Lemon, Orange), **Pomegranate**.

- Nutrient and physiological disorders (e.g., Mango - Spongy tissue, Malformation; Banana - K deficiency, Bunchy top; Papaya - Ring spot).

4. Major Fruit Crops of Tamil Nadu (Part II - Minor & Exotic)

- Production technologies and management for:
 - **Ber** (Indian Jujube), **Annona** (Custard apple, Sugar apple), **Amla** (Indian Gooseberry).
 - **Apple, Pear, Plum** (temperate fruits – where grown in TN high ranges).
 - **Avocado, Dragon fruit, Pineapple** (emerging/exotic high-value fruits).
- Specific nutrient/physiological disorders for these fruits.

5. Grape Cultivation and Specialized Management

- Climate and soil requirements for grapes in Tamil Nadu (specifically Theni, Dindigul, Madurai).
- Training systems (Bower, Telephone, Kniffin systems) and Pruning (Cane pruning, Spur pruning).
- Nutrient disorders (Potassium deficiency, Magnesium deficiency, Berry cracking) and PGR use (GA₃ for berry elongation).
- Post-harvest handling and raisin/ wine processing basics.

6. Importance and Classification of Vegetable Crops

- Nutritive value and dietary significance of vegetables.
- Classification based on:
 - Edible part (Roots, Tubers, Bulbs, Leaves, Fruits, Flowers, Pods/Seeds).
 - Season (Cool season vs. Warm season vegetables).
 - Botany (Solanaceous, Cucurbitaceous, Malvaceous, Cruciferous, Chenopodiaceous, Umbelliferous, Liliaceous).

7. Types of Vegetable Gardens and Propagation

- Types of Vegetable Gardens:
 - **Kitchen Garden** (Home food security).
 - **Nutritional Garden** (Combating malnutrition).

- **Truck Garden** (Large-scale market-oriented production).

- **Commercial Garden** (Export/Processing oriented).

- Propagation methods: Seed sowing (Direct/Nursery), Transplanting, and Vegetative propagation (Onion sets, Potato tubers, Cuttings for perennials).

8. Production Technologies for Solanaceous & Malvaceous Vegetables

- Climate, soil, varieties, sowing/transplanting, fertilizer, irrigation, weed control, harvest, and post-harvest for:
 - **Tomato, Brinjal (Eggplant), Chillies (Capsicum)** (Solanaceae).
 - **Bhendi (Okra/Lady's finger)** (Malvaceae).
- Nutrient/Physiological disorders: Blossom end rot (Tomato/Chilli), Fruit cracking, Dwarf disease.

9. Production Technologies for Bulb, Root & Tuber Vegetables

- Climate, soil, varieties, planting, fertilizer, irrigation, harvest, and storage for:
 - **Onion, Garlic** (Bulbs) – specific to Tamil Nadu's onion belts (Perambalur, Trichy).
 - **Potato, Beetroot, Carrot, Turnip** (Roots/Tubers) – cultivation in hilly regions (Nilgiris, Kodaikanal).
- Physiological disorders: Sprouting, Bolting, Splitting.

10. Production Technologies for Cucurbits, Greens, Crucifers & Perennials

- **Cucurbits:** Cucumber, Bitter gourd, Bottle gourd, Pumpkin, Snake gourd – trellising and sex modification using PGRs.
- **Crucifers (Cole crops):** Cauliflower, Cabbage – curd/head formation, buttoning disorder.
- **Greens:** Amaranthus, Spinach – quick harvest cycles.
- **Perennial vegetables:** Drumstick, Curry leaf, Moringa.

11. Importance, Propagation, and Production of Flower Crops

- Economic importance and domestic/export value of floriculture in Tamil Nadu.
- Propagation methods for flower crops (Cuttings for Rose/Chrysanthemum; Bulbs for Tuberose; Suckers for Jasmine; Seeds for Marigold).

- Role of PGRs (GA₃ for stem elongation; Ethrel for flower induction; Auxins for rooting).

12. Production Technologies for Major Traditional Flowers

- Climate/soil, varieties, planting, nutrient, irrigation, pinching/pruning, harvesting, and post-harvest for:
 - **Jasmine** (*Jasminum* – important in Tamil Nadu for garland industry).
 - **Rose** (Hybrid Tea, Floribunda – for cut flowers and essential oil).
 - **Chrysanthemum, Marigold, Tuberose, Crossandra, Cockscomb.**
- Nutrient/physiological disorders (e.g., Flower bud drop, Leaf chlorosis).

13. Garden Design and Landscape Architecture

- Principles of garden design.
- **Formal gardens:** Symmetrical, geometric patterns (e.g., Mughal, Italian).
- **Informal gardens:** Asymmetrical, naturalistic designs (e.g., English landscape).
- Components of a garden: Lawns, Pathways, Flower beds, Water features, Rockeries, Pergolas, and Fencing.

14. Lawns and Ornamental Plants (Annuals, Shrubs, Trees)

- **Lawns and lawn making:** Selection of grass species (Doob grass, Bermuda), Preparation of lawn, and maintenance (mowing, rolling, fertilizing).
- **Flowering Annuals:** Marigold, Petunia, Zinnia, Cosmos, Alyssum, Phlox, Pansy.
- **Flowering & Foliage Shrubs:** Hibiscus, Ixora, Bougainvillea, Duranta, Croton, Acalypha.
- **Flowering & Foliage Trees:** Gulmohar, Cassia, Royal Poinciana, Polyalthia, Ashoka.

15. Specialized Ornamental Horticulture (Climbers, Cacti, Indoor Plants)

- **Creepers and Climbers:** Bougainvillea, Clerodendron, Passion flower, Honeysuckle, Trumpet vine.
- **Cacti and Succulents:** Opuntia, Euphorbia, Agave, Aloe, Kalanchoe – their drought adaptation and ornamental use.
- **Indoor Plants and Indoor Decoration:** Selection of shade-tolerant foliage plants (Areca palm, Dracaena, Ficus, Ferns, Philodendron) for interiorscaping.

16. Cut Flowers, Flower Arrangement, Bonsai, and Dry Flowers

- **Cut Flowers:** Selection, harvesting stage, pre-cooling, pulsing, holding solutions, and grading for export (Rose, Gerbera, Carnation, Chrysanthemum).
- **Flower arrangement:** Principles of Ikebana (Japanese), Western, and Contemporary styles.
- **Bonsai Culture:** Principles, pot selection, training, pruning, and wiring of miniature trees.
- **Dry flower decoration:** Dehydration techniques (Silica gel, Air drying, Pressing, Glycerinizing) and value-added products.

17. Spice Crops: Production Technologies (Part I)

- Importance, climate/soil, propagation, planting, nutrient/irrigation management, harvesting, and post-harvest for:
 - **Pepper** (Black pepper – "King of Spices").
 - **Cardamom** (Small & Large – specific to high rainfall zones).
 - **Garlic, Clove, Nutmeg, Cinnamon, Allspice** (Allspice/Pimento).
- Nutrient/physiological disorders and management.

18. Spice Crops: Production Technologies (Part II - Rhizomatous & Seed Spices)

- Importance, climate/soil, propagation, planting, nutrient/irrigation, harvesting, and post-harvest for:
 - **Turmeric, Ginger** (Rhizomes – critical for Tamil Nadu's Erode region).
 - **Tamarind, Coriander, Fenugreek** (Seed spices).
- Physiological disorders (e.g., Rhizome rot, Leaf spot) and management.

19. Plantation and Medicinal Crops

- **Plantation Crops:** Climate, soil, propagation, planting, shade management (Coffee/Cocoa), tapping (Rubber), irrigation, nutrition, harvesting, and processing for:
Coffee (Arabica/Robusta Nilgiris/Yercaud), **Tea** (Nilgiris), **Coconut, Arecanut, Cashew, Cocoa, Rubber**.
- **Medicinal Crops:** Cultivation practices and active principle importance for:
Coleus (*Coleus forskohlii*), **Gloriosa** (Glory lily), **Ashwagandha** (*Withania*

somnifera), **Senna**, **Keezhanelli** (*Phyllanthus amarus*), **Agave**, **Thulasi** (Holy Basil), **Achorus** (Sweet flag).

20. Tissue Culture and Micropropagation of Horticultural Crops

- **Totipotency** – The cellular basis of plant tissue culture.
- **Regeneration** – Organogenesis vs. Somatic embryogenesis.
- **Callus culture** – Induction, maintenance, and its applications.
- **Somaclonal variation** – Causes and exploitation for crop improvement (disease resistance, stress tolerance).
- **Hardening/Acclimatization** – Step-down process (transfer from in-vitro to greenhouse to field) to ensure survival and vigor of tissue-cultured plants.

Unit V: Breeding and Seed Production (20 Questions) (20 Question sets)

1. Field Crops: Classification and Chemical Composition

- Importance of field crops in Indian agriculture (Food, Feed, Fiber, Fuel, Industrial raw materials).
- Agricultural classification (Cereals, Millets, Pulses, Oilseeds, Fibres, Sugar, Starch crops) and Industrial classification.
- Chemical composition of economic parts (Carbohydrates, Proteins, Fats/Oils, Cellulose, Starch, Sugar) in various crop groups.

2. Plant Physiology: Photosynthesis, Respiration, and Translocation

- Photosynthesis – Light and Dark reactions, C₃, C₄, and CAM pathways, and their significance in crop productivity.
- Respiration – Aerobic and Anaerobic, Glycolysis, Krebs cycle, Electron Transport Chain – energy release for growth.
- Translocation of assimilates – Phloem loading and unloading, Source-Sink relationships, and factors affecting partitioning of dry matter to economic yield.

3. Floral Biology and Pollination Systems

- Structure of a typical flower and modifications in crop plants.
- Reproductive systems: Sexual (Autogamy, Allogamy) and Asexual (Apomixis, Vegetative propagation).

- Mechanisms promoting Self-pollination (Cleistogamy, Chasmogamy, Position of anthers/stigma) and Cross-pollination (Dioecy, Monoecy, Dichogamy, Self-incompatibility, Male sterility).

4. Plant Genetic Resources (PGR)

- Definition, importance, and types of PGR (Gene pools - Primary, Secondary, Tertiary).
- Collection, exploration, and germplasm exchange.
- Characterization (Morphological, Biochemical, Molecular) and Conservation strategies (In-situ vs. Ex-situ – Gene banks, Seed banks, Cryopreservation, Field genebanks).

5. Self-Incompatibility and Male Sterility

- Self-incompatibility (SI): Gametophytic and Sporophytic types – applications and limitations in breeding.
- Male Sterility: Definition, classification (Genetic - GMS, Cytoplasmic - CMS, Cytoplasmic Genetic - CGMS, Environment-sensitive - EGMS/Photo-thermo sensitive).
- Gametocides (Chemical hybridizing agents) – their role in hybrid seed production and limitations.

6. Breeding Techniques for Self-Pollinated Crops

- Principles and procedures of:
 - **Pure line selection** – development of homozygous lines.
 - **Mass selection** – improvement of local varieties.
- **Hybridization and Selection:** Pedigree Method (individual plant selection for specific traits) and Bulk Method (mass selection after natural/artificial selection) – application in **Rice, Black gram, Groundnut**.

7. Two-Line and Three-Line Breeding in Rice

- **Three-line system:** CMS (A line), Maintainer (B line), Restorer (R line) – mechanism and utilization for hybrid rice.
- **Two-line system:** Environment-sensitive genic male sterility (EGMS) – using TGMS (Thermosensitive) or PGMS (Photoperiod-sensitive) lines as female parent and any fertile line as male parent – advantages over three-line system.

8. Breeding Techniques for Cross-Pollinated Crops

- Population improvement methods: Mass Selection and Recurrent Selection.
- **Backcross method** – transfer of a specific desirable gene (e.g., disease resistance) into a high-yielding variety.
- **Heterosis Breeding:** Exploitation of hybrid vigor – development of inbred lines, combining ability analysis, and hybrid development.

9. Hybrid and Synthetic/Composite Breeding

- Types of hybrids: **Single Cross** (A×B), **Double Cross** [(A×B)×(C×D)], and **Poly Cross** (multiple parents).
- Use of Male Sterile lines (CMS/EGMS) for economical hybrid seed production.
- **Synthetics** and **Composites** – population varieties maintained by open pollination – specific for crops like **Maize, Cumbu (Pearl Millet), Redgram, Cotton, Sorghum, Castor, Sunflower, Coconut.**

10. Breeding Methods for Vegetatively Propagated Crops

- **Clonal Selection** – selection of superior clones from natural variation.
- **Hybridization and Selection** in vegetatively propagated crops – handling of segregating populations.
- Specific applications for **Sugarcane, Tapioca (Cassava), Potato, and Fodder crops** (e.g., Napier grass, Guinea grass).

11. Mutation and Polyploidy in Crop Improvement

- **Mutation Breeding:** Physical (Gamma rays, X-rays) and Chemical (EMS, Sodium azide) mutagens – role in creating novel traits (e.g., dwarf wheat, seedless fruits).
- **Polyploidy:** Autopolyploids (e.g., triploid watermelon, tetraploid groundnut) and Allopolyploids (e.g., Triticale – wheat×rye) – advantages and limitations.
- **Interspecific Hybridization:** Wide crosses for transferring desirable traits (e.g., disease resistance, stress tolerance) – challenges and success stories.

12. Success Stories, Geographical Indications, and IPR

- Notable Indian success stories (Green Revolution - dwarf wheat/rice; Hybrid cotton/Bajra; Golden Rice; Biofortified varieties).

- **Geographical Indications (GI)** – protection of region-specific agricultural products (e.g., Navara rice, Mysore betel leaf, Nilgiri tea).
- **PPV&FR Act (Protection of Plant Varieties and Farmers' Rights Act)** – Breeders' rights, Farmers' rights, and benefit sharing.
- **Intellectual Property Rights (IPR)** – Patents, Plant Breeders' Rights (PBR), and their relevance in modern agriculture.

13. Seed: Importance and Quality Characteristics

- Definition of seed – its role as the basic input in agriculture.
- Seed quality characteristics: Physical purity, Genetic purity, Germination percentage, Seed vigor, Health, Moisture content.
- Classes of Seed (as per seed certification system): **Nucleus Seed → Breeder Seed → Foundation Seed → Certified Seed.**

14. Seed Production Guidelines, Multiplication Ratio, and Certification

- General guidelines for successful seed production: Selection of region, Isolation distance, Roguing, and Crop husbandry.
- **Multiplication Ratio** – its importance in determining the area required for seed multiplication at each generation.
- **Seed Certification:** Definition, general certification standards, and agencies (e.g., State Seed Certification Agency - TNSSCA).

15. Field Inspection, Certification Standards, and Seed Registration

- Field inspection procedures (Stages: Pre-flowering, Flowering, Maturity/Pre-harvest) – checking off-types, isolation, and disease incidence.
- Seed standards for different crops (Genetic purity, Minimum germination percentage, Physical purity, Moisture content).
- Seed registration process and documentation for marketing.

16. Pollination Biology and Environmental/Edaphic Factors

- Role of pollinators (Honey bees, Wind, Insects) in seed production – especially for cross-pollinated crops.
- Environmental factors (Temperature, Humidity, Light, Rainfall) affecting flowering, pollination, fertilization, and seed set.

- Edaphic factors (Soil texture, pH, Fertility) influencing seed quality and yield.

17. Seed Production Techniques for Cereals, Millets, and Pulses

- Variety and hybrid seed production for:
 - **Rice** (CMS-based hybrid seed production – synchronization of flowering, GA₃ application).
 - **Maize** (Detasseling for hybrid seed).
 - **Millets** (Pearl millet/Cumbu – use of CMS lines; Sorghum – hand emasculation or CMS).
 - **Pulses** (Black gram, Green gram, Red gram – maintaining isolation and roguing for varietal purity).

18. Seed Production Techniques for Cotton, Oilseeds, and Fodder Crops

- **Cotton:** Hybrid seed production (manual crossing vs. CMS system) and ensuring genetic purity in GMO (Bt cotton).
- **Oilseeds:** Groundnut (physical purity and avoiding mechanical mixing), Sunflower (use of CMS/Restorer system), Castor (emasculation for hybrids), Safflower.
- **Fodder Crops:** Seed production in Lucerne/Alfalfa (pollinator management), Sorghum fodder, and Clovers.

19. Seed Production Techniques for Important Vegetables

- Specific techniques (Isolation, Roguing, Pollination management, Harvesting of seed) for:
 - **Tomato, Brinjal (Eggplant), Chillies** – self-pollinated, ensuring varietal purity.
 - **Bhendi (Okra)** – hybrid seed production through hand emasculation.
 - **Lablab (Dolichos bean)** – managing pollinators.
 - **Onion** (bulb-to-seed and seed-to-seed methods).
 - **Cucurbits** (Bitter melon, Bottle melon, Cucumber) – hybrid seed production via hand pollination and use of gynodioecious lines.

20. Seed Harvesting, Processing, Treatment, Storage, Health, and Marketing

- **Harvesting:** Proper maturity indices for different crops to maximize seed quality.
- **Processing:** Threshing, Cleaning (Grading), Drying (Critical moisture levels).

- **Seed Treatment:** Chemical dressing, Biological agents (Trichoderma, Rhizobium coating), and Protective seed coatings.
- **Seed Storage:** Principles of storage – temperature, moisture control, and hermetic storage (e.g., Silos, Super bags). Factors affecting seed longevity.
- **Seed Health:** Seed-borne diseases (Fungi, Bacteria, Viruses) and their detection/inspection.
- **Seed Marketing:** Supply chain, branding, and distribution through Government agencies (e.g., TNAU, TNSSC), Cooperatives, and Private sectors.

Unit VI: Plant Protection Principles and Practices (30 Questions) (20 Question sets)

1. Fundamentals of Entomology and Economic Classification of Insects

- Definition and general characters of insects (Body segmentation - Head, Thorax, Abdomen; Antennae, Mouthparts, Wings, Legs).
- Economic classification of insects based on their association with humans:
 - **Harmful/Pest insects** (Crop pests, Stored grain pests, Vectors).
 - **Beneficial insects** (Pollinators, Predators, Parasitoids, Producers - Silk, Honey, Lac).
 - **Neutral/Indifferent insects** (Neither significantly harmful nor useful).

2. Sericulture: Mulberry Silkworm Rearing

- Definition and importance of sericulture in Tamil Nadu's rural economy.
- Mulberry cultivation – varieties, leaf harvesting, and nutrition.
- Rearing of Mulberry silkworm (*Bombyx mori*): Life cycle (Egg → Larva → Pupa → Moth), rearing house, appliances, disinfection, brushing, feeding, spacing, mounting, and cocoon harvesting.
- Diseases and pests of silkworm and their management.

3. Apiculture and Role of Bees in Crop Productivity

- Definition, importance, and bee species used for commercial honey production (*Apis cerana*, *A. mellifera*, *A. dorsata*, *A. florea*).
- Role of bees in crop productivity: Cross-pollination, increased fruit set, quality improvement, and yield enhancement in horticultural and field crops.

- Hiving of bees: Types of hives (Modern vs. Traditional), hive components, and Apiary management (site selection, seasonal management, swarm control, disease/pest management).
- Honey extraction, processing, and value addition.

4. Beneficial Insects: Pollinators, Predators, and Parasitoids

- **Insect Pollinators:** Bees, Butterflies, Moths, Beetles, Wasps, Flies – their role in natural and agricultural ecosystems.
- **Predators:** Insects that kill and feed on multiple prey (e.g., Ladybird beetles - *Coccinella*, Green lacewings - *Chrysoperla*, Praying mantids, Dragonflies).
- **Parasitoids:** Insects that lay eggs inside/on the host, eventually killing it (e.g., *Trichogramma* (egg parasitoid), *Bracon* (larval parasitoid), *Encarsia*).
- Conservation and augmentation of beneficial insects in agroecosystems.

5. Pest Concepts, Categories, and Outbreaks

- **Pest:** Definition – any organism (insect, mite, nematode, vertebrate) that causes economic damage to crops.
- Categories of pests based on:
 - **Occurrence:** Regular pests, Occasional pests, Seasonal pests, Persistent pests.
 - **Host range:** Monophagous, Oligophagous, Polyphagous.
 - **Damage potential:** Major pests, Minor pests, Key pests, Sporadic pests.
- **Pest outbreak:** Causes (Climatic factors, Monoculture, Invasive species, Insecticide resistance) and forecasting.

6. Pest Monitoring, Surveillance, and Economic Thresholds

- **Pest Surveillance:** Regular field monitoring to assess pest population and damage.
- **Pest Monitoring:** Tools and techniques – Light traps, Pheromone traps, Sticky traps, Yellow pan traps, Sweep nets, Visual counts.
- **Forecasting:** Prediction of pest outbreaks based on weather parameters and population dynamics.
- **Economic Threshold Level (ETL):** Pest population density at which control measures must be initiated to prevent reaching the EIL.

- **Economic Injury Level (EIL):** The lowest pest population that will cause economic damage (loss equals cost of control).

7. Pest Management Components – Cultural, Physical, Mechanical, Legal, and Host Resistance

- **Cultural control:** Crop rotation, Tillage, Sanitation, Trap crops, Border crops, Altering sowing/harvesting dates.
- **Physical/Mechanical control:** Hand picking, Light traps, Pheromone traps, Sticky traps, Heat treatment, Suction devices, Barriers (trenches, nets).
- **Legal/Regulatory control:** Quarantine regulations, Plant Protection Act, Restrictions on movement of infected plant material.
- **Use of Resistant Varieties:** Plant breeding for pest resistance (Horizontal vs. Vertical resistance; Antibiosis, Antixenosis, Tolerance).

8. Biological Control: Parasitoids, Predators, and Microbial Agents

- **Biological Control:** Definition and principles – classical, augmentative, and conservation biological control.
- **Parasitoids and Predators** – mass rearing and field release techniques.
- **Microbial agents:**
 - *Bacillus thuringiensis (Bt)* – bacterial insecticide.
 - *Metarhizium* and *Beauveria* – fungal pathogens.
 - NPV (*Nuclear Polyhedrosis Virus*) – viral control.
 - *Steinernema* and *Heterorhabditis* – entomopathogenic nematodes.

9. Pesticides: Groups, Classification, Mode of Action, and Formulations

- Definition and classification of pesticides based on:
 - **Target organism:** Insecticides, Fungicides, Herbicides, Rodenticides, Acaricides, Nematicides.
 - **Chemical nature:** Organochlorines, Organophosphates, Carbamates, Pyrethroids, Neonicotinoids, Insect Growth Regulators (IGRs), Biopesticides.
 - **Mode of action:** Contact, Stomach, Systemic, Fumigant, Respiratory inhibitors, Nervous system disruptors.

- Common formulations: WP (Wettable Powder), EC (Emulsifiable Concentrate), SC (Suspension Concentrate), GR (Granules), DP (Dust), SL (Soluble Liquid).

10. Pesticide Application, Hazards, Safe Handling, and Residue Management

- Principles of pesticide application: Right dosage, Right timing, Proper calibration of sprayers, Covering plant parts effectively.
- Hazards in pesticide use: Toxicity to applicators, Non-target organisms (Beneficial insects, Pollinators, Aquatic life), Environmental pollution (Soil, Water, Air).
- Safe handling practices: Personal Protective Equipment (PPE), Proper storage and disposal, FIFO principle, Avoiding drift.
- **Pesticide residue:** Definition, Maximum Residue Limits (MRLs), Pre-harvest interval (PHI), Waiting period, and residue degradation methods.
- New and organic pesticides: Neem-based formulations, Spinosad, Emamectin benzoate, Chlorantraniliprole – their advantages and limitations.

11. Behavior Modifying Chemicals and Pheromones

- **Pheromones:** Definition, types (Sex pheromone, Aggregation pheromone, Alarm pheromone, Trail pheromone).
- Use of pheromones in pest management: Mass trapping, Monitoring/Detection, Mating disruption.
- **Behavior modifying chemicals:** Kairomones, Allomones, Synomones – their role in host location and repellency.
- Integrated use of semiochemicals with other control methods (Push-Pull strategy – trap crops with repellents/attractants).

12. Insect and Non-Insect Pests – Damage Symptoms and Life Cycle (Part I – Field Crops)

- Damage symptoms, life cycle, and Integrated Management practices for major pests of:
 - **Rice:** Yellow stem borer, Brown planthopper (BPH), Leaf folder, Gall midge.
 - **Millet:** Shoot fly, Stem borer, Earhead bug.
 - **Cotton:** Bollworms (American, Pink, Spotted), Whitefly, Leafhopper, Thrips.
 - **Sugarcane:** Early shoot borer, Top borer, Scale insect, White grub.
 - **Pulses:** Pod borer (*Helicoverpa*), Spotted pod borer, Aphids, Whitefly.

- **Oilseeds:** Groundnut – Leaf miner, Tobacco caterpillar; Sunflower – Head borer; Castor – Castor semilooper; Gingelly – Pod borer.

13. Insect and Non-Insect Pests (Part II – Vegetable Crops)

- Damage symptoms, life cycle, and Integrated Management for:
 - **Brinjal:** Shoot and fruit borer, Epilachna beetle, Jassids.
 - **Tomato:** Fruit borer (*Helicoverpa*), Leaf miner, Whitefly.
 - **Bhendi (Okra):** Shoot borer, Fruit borer, Leafhopper.
 - **Cucurbits:** Red pumpkin beetle, Fruit fly, Epilachna, Aphids.
 - **Crucifers (Cabbage/Cauliflower):** Diamond back moth, Cabbage caterpillar, Aphids, Tobacco caterpillar.
 - **Moringa:** Hairy caterpillar, Leaf caterpillar, Bud borer.
 - **Tapioca:** Whitefly, Stem borer, Scale insect.
 - **Chillies, Onion:** Thrips, Mites, Cutworms.

14. Insect and Non-Insect Pests (Part III – Plantation, Spices, Flower Crops, and Fruits)

- Damage symptoms, life cycle, and Integrated Management for:
 - **Coconut:** Rhinoceros beetle, Red palm weevil, Black headed caterpillar, Eriophyid mite.
 - **Arecanut:** Mite, Spindle bug, White grub.
 - **Turmeric, Curry-leaf, Betelvine:** Scale insects, Shoot borer, Leaf roller, Aphids.
 - **Coffee:** Coffee berry borer, White stem borer, Leaf miner.
 - **Tea:** Tea mosquito bug, Termites, Mites.
 - **Cardamom:** Shoot borer, Thrips, Mite, Root grub.
 - **Pepper:** Pollu beetle, Longicorn beetle, Scale insects.
 - **Flower crops (Rose, Jasmine, Crossandra, etc.):** Mites, Aphids, Thrips, Bud borer, Flower beetle.
 - **Fruit crops:** Mango – Mango hopper, Stone weevil, Mealybug; Citrus – Citrus psylla, Leaf miner, Butterfly; Banana – Rhizome weevil, Aphids; Grapes – Flea beetle, Thrips, Mealbugs; Sapota – Sooty mould complex (due to

scale/mealybugs), Borers; Guava – Fruit fly, Guava scale; Pomegranate – Anar butterfly, Aphids, Thrips.

15. Pests of Stored Products and Their Management

- Major stored grain pests: Rice weevil (*Sitophilus oryzae*), Angoumois grain moth (*Sitotroga cerealella*), Khapra beetle (*Trogoderma*), Pulse beetle (*Callosobruchus*), Red flour beetle (*Tribolium*), Grain borer.
- Damage symptoms (grain weight loss, reduced germination, webbing, frass).
- Integrated management: Storage hygiene, Disinfestation (Sun drying, Smoking, Fumigation with Aluminium phosphide), Hermetic storage, Botanicals (Neem leaf powder), Biological (Parasitoids – *Bracon hebetor*), Resistant storage structures.

16. Plant Disease Fundamentals – Causes, Categories, and Mode of Spread

- Definition of plant disease – Disease triangle (Host + Pathogen + Environment).
- Causes of plant diseases:
 - **Fungi:** Mycelial nature, spores – examples (Rusts, Smuts, Downy mildews, Powdery mildews).
 - **Bacteria:** Single-celled, motility – examples (Bacterial blight, Bacterial wilt, Canker, Soft rot).
 - **Viruses:** Obligate parasites, capsid + nucleic acid – examples (Leaf curl, Mosaic, Yellowing).
 - **Mycoplasma (Phytoplasma):** Wall-less, pleomorphic – examples (Sandal spike, Little leaf).
- Categories based on occurrence (Sporadic, Endemic, Epidemic/Pandemic) and host range (Monophagous, Oligophagous, Polyphagous).
- Mode of spread: Soil-borne, Seed-borne, Air-borne, Water-borne, Insect/Vector-borne, Mechanical.
- Environmental factors influencing disease outbreaks: Temperature, Humidity, Rainfall, Wind, Soil moisture/pH.

17. Principles of Plant Disease Control

- **Exclusion:** Quarantine, Inspection, Certification, Use of disease-free seed/planting material.

- **Eradication:** Roguing of infected plants, Removal of alternate hosts, Soil solarization, Heat treatment.
- **Immunization (Host resistance):** Breeding for resistance (Gene-for-gene concept, Vertical/Horizontal resistance).
- **Protection:** Use of chemical fungicides, biological agents, and cultural practices to protect the host from infection.

18. Cultural and Biological Control of Plant Diseases

- **Cultural methods:** Crop rotation, Sanitation, Adjusting sowing time, Proper spacing, Balanced nutrition, Water management, Intercropping.
- **Biological Control:**
 - Antagonistic organisms – *Trichoderma* spp. (against soil-borne fungi - *Fusarium*, *Rhizoctonia*, *Sclerotium*).
 - *Pseudomonas fluorescens* (against bacterial and fungal pathogens – seed treatment/soil application).
 - *Bacillus subtilis* – broad-spectrum antagonistic activity.
- **Useful Fungi – Mushroom Cultivation:**
 - Nutritional and economic importance of Oyster mushroom (*Pleurotus* spp.) – substrate preparation, spawning, cropping, harvesting.
 - *Trichoderma* – also used as biocontrol agent (besides being a contaminant in mushroom cultivation).

19. Fungicides: Characteristics, Groups, Formulations, and Phytotoxicity

- Characteristics of a good fungicide: High fungitoxicity, Low phytotoxicity, Broad spectrum, Systemic/Contact ability, Easy degradability.
- Major groups of fungicides:
 - **Inorganic:** Sulphur, Copper (Bordeaux mixture, Copper oxychloride).
 - **Organic:** Dithiocarbamates (Mancozeb, Ziram), Triazoles (Tebuconazole, Propiconazole), Strobilurins (Azoxystrobin, Trifloxystrobin), Benzimidazoles (Carbendazim), Phenylamides (Metalaxyl), Antibiotics (Streptomycin, Kasugamycin).
- Formulations and application methods.

- **Phytotoxicity:** Definition, symptoms (Leaf scorch, Necrosis, Yellowing, Stunting), factors causing phytotoxicity (overdose, high temperature, wrong stage), and precautions.
- Antibiotics in disease management – Streptomycin sulphate, Tetracycline for bacterial diseases.

20. Integrated Disease and Pest Management (IDM/IPM) in Major Crop Groups

- Integration of cultural, biological, chemical, and host resistance for holistic management.
- Assessment of crop diseases and losses – Disease severity scales (0-5 scale, 0-9 scale), incidence vs. severity, yield loss estimation models.
- Biotechnology in disease management – Pathogen-derived resistance (e.g., Coat-protein mediated resistance), Gene pyramiding, Marker-assisted selection for disease resistance, RNAi technology.
- **IDM/IPM modules for major diseases caused by Fungi, Bacteria, Viruses, and Mycoplasma in:**
 - **Cereals:** Rice (Blast, Blight, Sheath rot), Millets (Downy mildew, Rust, Ergot).
 - **Pulses:** Black gram/Green gram (Yellow mosaic virus - YMV, Powdery mildew, Anthracnose), Red gram (Fusarium wilt, Sterility mosaic).
 - **Oilseeds:** Groundnut (Leaf spots - Tikka, Rust), Sunflower (Downy mildew, Sclerotinia rot), Castor (Blight, Wilt).
 - **Cash crops:** Cotton (Wilt, Grey mildew, Boll rot), Sugarcane (Red rot, Smut).
 - **Fruits:** Mango (Powdery mildew, Anthracnose, Dieback), Citrus (Canker, Greening), Banana (Sigatoka leaf spot, Panama wilt), Grapes (Downy mildew, Powdery mildew, Anthracnose).
 - **Vegetables:** Tomato (Late blight, Early blight, Leaf curl virus), Brinjal (Phomopsis blight, Wilt, Little leaf - phytoplasma), Bhendi (Yellow vein mosaic virus, Powdery mildew), Crucifers (Downy mildew, Alternaria leaf spot, Black rot - bacterial).
 - **Plantation & Spice crops:** Coffee (Rust - Hemileia), Tea (Blister blight), Cardamom (Kapoor leaf spot, Wilt), Pepper (Phytophthora foot rot - Quick wilt), Turmeric (Rhizome rot, Leaf blotch).

- **Flower crops:** Rose (Powdery mildew, Black spot, Dieback), Chrysanthemum (Rust, Wilt, Leaf spot), Jasmine (Fusarium wilt, Leaf spot).
- Final integration into a comprehensive Plant Protection Strategy for sustainable agriculture.

Unit VII: Livestock, Poultry Management, Artificial Insemination and Calf Rearing (10 Questions) (15 sets of Questions)

1. Significance of Livestock and Poultry in the Indian Economy

- Contribution of the livestock sector to India's GDP and agricultural GVA.
- Role in employment generation (especially rural and women), supplementary income, draft power, manure, and nutrition security.
- Importance of livestock in the mixed farming and integrated farming systems of Tamil Nadu.
- Manure management methods: Farm Yard Manure (FYM), Composting, Vermicomposting, Slurry management, and their role in soil health.

2. Systems of Livestock Production and Breeding Fundamentals

- Various systems of livestock production:
 - **Extensive:** Large grazing lands, low input.
 - **Semi-intensive:** Restricted grazing with some supplementation.
 - **Intensive:** Zero grazing, complete confinement, high input.
 - **Mixed:** Integration with crop production.
- **Definition of Breed:** A group of animals with common ancestry and similar characteristics.
- Classification of indigenous cattle (*Bos indicus*), exotic cattle (*Bos taurus*), and buffaloes.
- Breed characteristics of:
 - **Indigenous cattle:** Sindhi, Kangeyam, Umblachery.
 - **Exotic cattle:** Jersey, Holstein Friesian.
 - **Buffaloes:** Murrah, Surti.

- Importance of crossbreeding for combining disease resistance/draught power (indigenous) with high milk yield (exotic).

3. Artificial Insemination (AI): Merits, Demerits, and Techniques

- Definition and scientific principles of Artificial Insemination.
- **Merits:** Better sire utilization, genetic progress, disease control (venereal), cheap and efficient, use of frozen semen.
- **Demerits:** Requires skilled technicians, risk of poor heat detection, transmission of certain diseases if hygiene is poor, initial infrastructure cost.
- Semen collection, evaluation, dilution, preservation, and insemination techniques (recto-vaginal method).

4. Housing Management for Dairy Animals

- Farm site selection criteria (Topography, Drainage, Water availability, Proximity to market, Wind direction).
- Space requirements for calves, heifers, milch animals, and work bullocks.
- Type and design of houses: **Traditional** vs. **Modern/Model** dairy barns.
- Systems of housing:
 - **Single row system:** One row of animals facing outward/inward – merits (simpler, cheaper) and demerits (space utilization).
 - **Double row system:**
 - **Head to head:** Animals face each other – merits (common feed passage) and demerits (cross-contamination risk).
 - **Tail to tail:** Animals face outward – merits (better ventilation, cleaner) and demerits (requires two feed passages).

5. Care and Management of Calves, Heifers, and Adult Animals

- **Care of new-born calf:** Colostrum feeding (within 1-2 hours), naval cord disinfection, weaning, dehorning, identification, and vaccination schedules.
- **Care and management of heifers:** Proper growth feeding, age at first service/calving, health monitoring, and udder development.
- **Care of pregnant animals:** Dry period management, proper nutrition (steaming up), vaccination, and preparation for parturition.

- **Care of lactating animals:** Feeding according to milk production (lactation curve), milking routines, udder hygiene, and drying off management.
- **Care of work bullocks:** Balanced nutrition, rest periods, proper shoeing, and draft load management.

6. Milk: Definition, Clean Milk Production, and Milking Methods

- Definition of milk as per FSSAI – the normal mammary secretion.
- **Clean milk production:** Principles – healthy animal, clean udder, clean milking equipment, hygienic environment, and rapid cooling.
- **Methods of milking:**
 - **Hand milking:** Full hand method vs. Knuckling method – advantages (low cost) and disadvantages (slow, contamination risk).
 - **Machine milking:** Milking machines – advantages (fast, hygienic, complete milking) and disadvantages (capital cost, requires power, mastitis risk if faulty).

7. Milk Processing: Pasteurization Methods

- Importance of processing milk for safety and shelf life.
- **Cooling:** Immediate cooling to 4°C to arrest bacterial growth.
- **Pasteurization:** Definition – heating milk to destroy pathogenic bacteria without altering nutritional quality.
- **Methods:**
 - **LTLT (Low Temperature Long Time):** 63°C for 30 minutes – batch method.
 - **HTST (High Temperature Short Time):** 72°C for 15 seconds – continuous flow method (most common).
- Advantages (pathogen-free, extended shelf life) and disadvantages (loss of some vitamins, initial investment) of pasteurization.

8. Animal Nutrition: Ration, Balanced Diet, and Fodder Management

- **Nutrition:** Definition – the science of feed utilization by the animal body.
- **Ration:** The feed allowed to an animal over 24 hours.
- **Balanced composition of concentrate feed:** For dairy animals (lactation/gestation), calves (growth), and work bullocks (energy/protein ratio).

- **Importance of green fodder:** Provides proteins, vitamins, minerals, and improves palatability/digestibility.
- **Carrying capacity:** Number of animals that can be sustained per unit area of pasture/fodder land.
- **Forage cycle:** Planning year-round fodder production (Cultivated fodders like Cumbu Napier, Hedge Lucerne, Cowpea, Berseem) to avoid lean periods.

9. Classification of Animal Diseases and General Control Measures

- Classification based on etiology:
 - **Viral:** Foot and Mouth Disease (FMD), Rinderpest, Blue Tongue.
 - **Bacterial:** Anthrax, Haemorrhagic Septicaemia (HS), Black Quarter (BQ), Tuberculosis, Brucellosis.
 - **Metabolic:** Tympanites (Bloat), Ketosis (Acetonemia), Milk Fever (Parturient Paresis), Grass Tetany.
- General control and preventive measures: Quarantine, Vaccination, Sanitation, Deworming, Balanced nutrition, and Biosecurity.
- **Mastitis:** Definition, causes (bacterial – *Staphylococcus*, *Streptococcus*, *E. coli*), symptoms (inflammation of udder, abnormal milk), diagnosis (California Mastitis Test - CMT), control (milking hygiene, dry cow therapy, teat dipping, and antibiotic treatment).

10. Zoonotic Diseases and Their Prevention

- Definition of Zoonoses – diseases transmitted from animals to humans.
- Important zoonotic diseases in livestock:
 - **Anthrax:** *Bacillus anthracis* – prevention (vaccination, quarantine, proper disposal of carcasses).
 - **Tuberculosis:** *Mycobacterium bovis* – prevention (test and cull policy).
 - **Brucellosis:** *Brucella* spp. – prevention (vaccination of calves, test and cull, abortion hygiene).
 - **Rabies:** Lyssavirus – prevention (vaccination of dogs, post-exposure prophylaxis for humans).
- Public health importance and One Health approach.

11. Sheep and Goat Farming: Breeds, Rearing Systems, and Housing

- Classification of breeds:
 - **Goat:** Indigenous (Jamunapari, Tellicherry, Osmanabadi, Kanni), Exotic (Saanen, Alpine, Boer).
 - **Sheep:** Indigenous (Mandya, Kilakarsal, Mecheri), Exotic (Merino, Rambouillet).
- Systems of rearing: Extensive (grazing), Semi-intensive (partial stall feeding), Intensive (complete stall feeding).
- Housing management: Type and design, floor diagram, space requirements for adult and young stock.
- Common tree fodders for small ruminants: Subabul, Agathi (Sesbania), Glyricidia, Ficus, Leucaena, and Acacia pods.

12. Common Ailments and Management of Sheep and Goat

- **Sheep Pox:** Viral – symptoms (skin lesions), prevention (vaccination).
- **Foot and Mouth Disease (FMD):** Vesicular lesions on feet/mouth – vaccination.
- **Blue Tongue:** Viral, vector-borne (*Culicoides* midges) – symptoms (cyanotic tongue, lameness).
- **Enterotoxaemia:** Bacterial (Clostridial) – sudden death, prevention (vaccination against overeating disease).
- **Ectoparasites:** Ticks, Mange mites, Lice – control through acaricides.
- **Endoparasites:** Gastrointestinal nematodes, Liver fluke – control through strategic deworming and pasture rotation.
- Nutritional management and preventive health schedule.

13. Systems of Poultry Rearing and Brooding Management

- **Backyard poultry:** Free-range, low input, native breeds for eggs/meat – role in rural livelihoods.
- **Intensive systems:** Commercial production.
- **Nomenclature of commercial strains:**
 - **Layers:** BV 300, BV 380, Babcock, White Leghorn, Rhode Island Red.

➤ **Broilers:** Cobb, Vencobb, Ross 308 – bred for fast growth and feed efficiency.

- **Care and management of day-old chicks:** Brooder management – providing artificial heat (temperature schedule), brooder guards, provision of feed/water (starter mash), vaccination schedules, and debeaking.

14. Poultry Housing and Litter Management

- **Deep litter system:** Birds on absorbent litter material – merits (low cost, less stress, exercise) and demerits (disease risk, litter management required).
- **Cage system:** Battery cages – merits (hygiene, higher stocking density, efficient egg collection) and demerits (higher cost, restricted movement, reduced immunity).
- **Raised platform housing:** Elevated slatted floors for better hygiene and aeration.
- Floor space requirements for different ages.
- Litter management: Importance of dry litter, turning, and replacement – control of ammonia and fungal infections.
- **Care and management of layers:** Lighting management (photoperiod for egg production), feeding schedules, vaccination, and molt management.
- **Care and management of broilers:** Intensive feeding (ad-libitum), strict biosecurity, and shorter rearing cycles (6-8 weeks).

15. Poultry Nutrition, Diseases, and Government Schemes

- **Composition of poultry mashes:**
 - **Chick mash (starter):** High protein (20-22%) and energy.
 - **Grower mash:** Moderate protein (16-18%) – for replacement pullets.
 - **Layer mash:** Calcium-rich (3-4%), protein (16-18%).
 - **Broiler starter/finisher:** High energy and protein (22-24% starter, 18-20% finisher).
- **Feed Conversion Ratio (FCR):** Kg feed per dozen eggs (layers) or Kg feed per Kg meat (broilers) – economic efficiency indicator.
- **Classification of poultry diseases:**
 - **Viral:** Ranikhet disease (Newcastle Disease – ND) – symptoms (respiratory distress, greenish droppings, mortality) – prevention via vaccination.
 - **Bacterial:** Infectious Bursal Disease (Gumboro) – immunosuppression, vaccination.

- **Bacterial:** *E. coli* (Colibacillosis), Coryza (Infectious coryza), Salmonellosis – prevention via sanitation and antibiotics.
- **Protozoan:** Coccidiosis (*Eimeria* spp.) – symptoms (bloody droppings), prevention via anticoccidials and litter management.
- **Vitamin and mineral deficiencies:** Rickets (Ca/P/Vit D3), Perosis (Manganese), Vitamin A deficiency (night blindness), Vitamin B deficiency (polyneuritis) – prevention via balanced premixes.
- **Schemes, Policies, and Subsidies in Animal Husbandry by Tamil Nadu:**
 - *Kudumiyamalai scheme* (Livestock development).
 - *Uzhavan Thittam* (integrated farming subsidy).
 - Subsidies for dairy infrastructure, AI services, feed supplements, poultry shed construction, and insurance coverage (Livestock Insurance Scheme).

Unit VIII: Farm Machinery, Post Harvest Technology and Energy and Environment (10 Questions) (10 set of Questions)

1. Farm Infrastructure: Threshing Floors, Drying Floors, and Machinery Basics

- **Threshing floor:** Definition, types (Packed earth, Concrete, Bricks), and their importance for separating grains from panicles/ears.
- **Drying floor:** Types (Open yard, Concrete platform, Raised drying beds) – purpose and construction for sun drying of produce.
- **I.C. Engines (Internal Combustion Engines):** Types – Petrol (Spark Ignition) and Diesel (Compression Ignition) engines; 2-stroke vs. 4-stroke engines.
- Preventive maintenance and minor repairs: Air filter cleaning, oil change, fuel filter maintenance, spark plug/glow plug checks, cooling system maintenance, and troubleshooting common starting/running issues.

2. Tractors: Systems, Hydraulics, Clutch, Transmission, and Hitching

- Tractor – definition and classification (Based on horsepower - Small, Medium, Large).
- Different systems of a tractor:
 - **Engine system** (Cooling, Lubrication, Fuel injection).

- **Hydraulic system:** Principle, components (Hydraulic pump, Control valve, Lift cylinder, 3-point linkage) – importance for implement control and draft/position control.
- **Clutch system:** Single plate, Dual clutch – function and maintenance.
- **Transmission system:** Gearbox (Sliding mesh, Constant mesh, Synchromesh), Differential, Final drive – power transmission from engine to wheels.
- Hitching of implements to tractors: Drawbar hitch, 3-point linkage (Category I, II, III) – proper hitching for optimum performance.

3. Power Tillers, Matching Implements, Seeders, Planters, and Sprayers

- **Power Tiller:** Definition, components (Engine, Rotary tiller blades, Clutch, Transmission), advantages (lightweight, suitable for small holdings/wet paddy), and limitations.
- Matching implements for tractors and power tillers:
 - Tillage: Disc plough, Mouldboard plough, Cultivator, Harrow, Rotavator.
- **Seeders and Planters:**
 - Seed drills (broadcasting/line sowing).
 - Planters (Precision planters for maize, cotton, groundnut – ensures specific spacing and depth).
- **Plant Protection Equipment:**
 - Hand operated: Knapsack sprayer, Rocker sprayer, Hand compression sprayer.
 - Power operated: Power sprayer, Mist blower, Ultra Low Volume (ULV) sprayer.
 - Calibration and maintenance of sprayers.

4. Harvesting Machinery and Agricultural Pumps

- **Harvesting machinery:**
 - Reaper – for cutting standing crops.
 - Combine Harvester – combined reaping, threshing, and winnowing – suitability for paddy, wheat, maize.
 - Sugarcane harvester.
 - Potato digger/harvester.

- **Agricultural Pumps:**
 - Types: Centrifugal pumps (most common), Reciprocating pumps, Submersible pumps, Propeller pumps, and Turbine pumps.
 - Selection criteria: Discharge required, Total head, Power source (Electricity/Diesel), and cost.
- **Custom Hiring Centre (CHC):** Concept, importance for small/marginal farmers to access expensive machinery on rent.
- **E-vadagai:** Tamil Nadu's online platform for custom hiring of agricultural machinery and implements.

5. Post-Harvest Losses and Moisture Determination

- **Post-harvest losses:** Definition, types (Quantitative – physical loss; Qualitative – loss in nutritional, germination, market quality). Losses in durable crops (grains/pulses) vs. perishable crops (fruits/vegetables).
- **Moisture Content:** Definition – critical for safe storage and processing.
- **Methods of determination:**
 - **Direct methods:** Oven drying method (hot air oven), Distillation method (Toluene).
 - **Indirect methods:** Moisture meters (Electrical resistance, Capacitance type) – quick estimation.
- Importance of correct moisture determination for safe storage and processing.

6. Drying, Shelling, Decortication, and Parboiling of Paddy

- **Drying:**
 - **Sun drying:** Open yard/drying floor – merits (low cost, no fuel) and demerits (weather dependent, contamination, uneven drying, labour intensive).
 - **Mechanical drying:** Types – Batch dryer, Continuous flow dryer, Fluidized bed dryer – merits (controlled conditions, quick, hygienic) and demerits (capital cost, fuel/electricity required, skilled operation).
- **Shelling and Decortication:**
 - **Rubber Roll Sheller:** Used for paddy – two rubber rolls rotating at different speeds to remove husk.

- **Centrifugal Dehusker:** Used for pulses/other grains – impact method to remove outer coat.

- **Parboiling of Paddy:** Soaking → Steaming → Drying – merits (increases milling yield, reduces breakage, better nutrition) and demerits (requires energy, changes colour/taste).

7. Milling, Polishing, Seed Treatment, and Storage of Grains

- **Milling of Corn (Maize):** Dry milling vs. Wet milling – products (flour, grits, starch, oil).
- **Milling of Pulses:** Dehusking and splitting (using disk mills/emery rollers) – challenges (hard-to-cook, split loss).
- **Polishing of Rice:** Removal of bran layers using polishers – merits (better appearance, market value) and demerits (loss of nutrients – vitamins/minerals).
- **Seed Treater:** Types – Slurry treater, Mist treater, Dust treater – for applying fungicides/insecticides to seeds.
- **Storage of Grains and Seeds:** Conditions for safe storage – moisture (<12-14%), temperature control, aeration, pest-free environment, and clean storage structures (Silos, Godowns, CAP storage, Hermetic bags/PICS bags).
- Value addition and suitable machineries for major food grains: Graders (size/sorting), Packing machines, and Mini dal mills / rice mills.

8. Energy Resources: Conventional, Non-Conventional, and Solar Energy

- **Energy Resources:** Classification – Primary vs. Secondary, Commercial vs. Non-commercial.
- **Conventional Energy:** Fossil fuels (Coal, Petroleum, Diesel, Natural gas) – finite, polluting.
- **Non-Conventional (Renewable) Energy:** Solar, Wind, Biomass, Tidal, Geothermal – sustainable and eco-friendly.
- **Solar Energy:** Principles – Photovoltaic (PV - direct electricity) and Solar Thermal (heat generation).
 - **Merits:** Abundant, clean, renewable, low operating cost, decentralized application.

- **Limitations:** Intermittent availability, high initial cost, storage challenges, low efficiency, large land area.

- Applications in agriculture: Solar dryers, Solar pumps, Solar fencing, Solar lighting.

9. Bio-Mass Energy, Biogas Plants, and Biofuels

- **Energy from Bio-Mass:** Sources – agricultural residues (straw, husk, bagasse), animal dung, sugarcane trash, vegetable wastes.
- **Technologies:** Direct combustion, Gasification, Pyrolysis, Anaerobic digestion.
- **Biogas Plants:**
 - **Classification:** Fixed dome (e.g., Deenbandhu model) vs. Floating drum (e.g., KVIC model).
 - **Types:** Family-type small plants vs. Community/large-scale plants.
 - **Biogas from plant wastes:** Using crop residues / weeds (parthenium, water hyacinth) – co-digestion with dung for improved yield.
 - **Utilization of biogas:** Cooking (stoves), Lighting, Electricity generation (via generator), and as vehicle fuel after compression.
- **Biofuel Plant:** Production of biodiesel from non-edible oilseeds (Jatropha, Pongamia), ethanol from sugarcane/maize, and their blending with fossil fuels.
- **Gasifiers:** Thermo-chemical conversion of biomass into producer gas (combustible mixture of CO, H₂, CH₄) – used for running engines/pumps.
- **Smokeless Chulas:** Improved biomass cookstoves – higher efficiency, reduced indoor air pollution.

10. Ecology, Environmental Pollution, Climate Change, and Eco-Safe Agriculture

- **Ecology:** Definition – study of inter-relationships between organisms and their environment. Natural resources – Land, Water, Air, Forests, Biodiversity.
- **Environmental Pollution and Management:**
 - **Atmospheric Pollution:** Sources – industrial emissions, vehicular exhaust, agricultural burning, particulate matter (PM_{2.5}, PM₁₀).
 - **Smog:** Formation (photochemical smog) – effects on health and agriculture (reduced photosynthesis).

- **Acid rain:** Formation of $\text{H}_2\text{SO}_4/\text{HNO}_3$ from SO_x/NO_x – effects (soil acidification, forest decline, water body acidification, crop damage).
- **Ozone hole:** Depletion of stratospheric ozone by CFCs/HFCs – increased UV radiation – effects on crops and human health.
- **Global Warming and Climate Change:**
 - **Causes:** Greenhouse gases (CO_2 , CH_4 , N_2O , CFCs) from agriculture (livestock, rice paddies, fertilizer use), industry, and deforestation.
 - **Effects:** Temperature rise, erratic rainfall, sea-level rise, increased pest/disease incidence, reduced crop yields.
 - **Control measures:** Mitigation (Carbon sequestration, afforestation, reducing GHGs) and Adaptation (climate-resilient crops/varieties, conservation agriculture, water harvesting).
- **Traditional farming methods:** Organic farming, Mixed cropping, Crop rotation, Green manuring – their role in sustainability.
- **Eco-Safe technologies in agriculture:**
 - Precision farming, Integrated Nutrient/Pest Management (INM/IPM).
 - Zero tillage, Conservation agriculture.
 - Biofertilizers, Biopesticides, Vermicomposting.
 - Use of renewable energy (solar pumps, biogas) and waste recycling.
 - Carbon footprint reduction in agriculture through carbon farming and agroforestry.

Unit IX: Commercial Agriculture (20 Questions) (25 set of Questions)

1. Bio-Control Agents: Role and Categories

- Definition of biological control and its importance in sustainable pest and disease management.
- **Categories of bio-control agents:**
 - **Macrobials:** Parasitoids, Predators, and Entomopathogenic nematodes.
 - **Microbials:** Bacteria (*Bt*), Fungi (*Trichoderma*, *Beauveria*), Viruses (NPV), and Actinomycetes.

- **Biochemicals:** Semiochemicals (Pheromones, Kairomones) and Plant extracts (Neem).

- Advantages (eco-friendly, target-specific, no residue) and limitations (slow action, variable efficacy, storage issues) of bio-control.

2. Setting Up a Bio-Control Laboratory

- Facility requirements: Location, layout (Media preparation room, Inoculation room, Incubation room, Storage room, Wash room).
- Essential equipment: Laminar air flow hood, Autoclave, Hot air oven, Incubator, Refrigerator, Centrifuge, Microscopes, and Glassware.
- Raw materials for media preparation: Agar, Dextrose, Yeast extract, Peptone, and other nutrients.
- Sterilization techniques and aseptic conditions.
- Safety protocols and waste disposal procedures.

3. Mass Production of Insect Pests for Host Rearing

- Importance of rearing host insects for production of bio-control agents.
- **Mass culture of Tobacco caterpillar (*Spodoptera litura*):** Rearing on artificial diet (Chickpea flour, Yeast, Sorbic acid, Agar) or natural host plants (Castor, Groundnut).
- **Mass culture of Gram pod borer (*Helicoverpa armigera*):** Synthetic diet preparation (Chickpea based), oviposition cages, incubation, and larval rearing.
- **Mass production of SINPV (*Spodoptera litura* NPV) and HaNPV (*Helicoverpa* NPV):** Infection of target larvae, collection of infected larvae, homogenization, filtration, centrifugation, formulation, and storage.

4. Mass Production of Parasitoids, Predators, and Microbial Antagonists

- **Mass production of *Trichogramma* spp. (Egg parasitoid):** Use of *Corcyra* (*Corcyra cephalonica*) eggs as host, UV irradiation, parasitization, and card preparation for field release.
- **Mass production of *Chrysoperla* (Green lacewing - Predator):** Rearing on artificial diet/alternative prey (*Corcyra* eggs), adult feeding, egg collection, and larval rearing.
- **Mass production of Coccinellid predators (Ladybird beetles):** Rearing on aphids (*Rhopalosiphum*), adult mating, oviposition, and larval rearing.

- **Mass production of *Trichoderma viride*:** Solid-state fermentation (SSF) on grains (Sorghum/Rice), liquid fermentation, and formulation as wettable powder.
- **Mass production of *Pseudomonas fluorescens*:** Nutrient broth/slant cultures, liquid fermentation, and carrier-based (Talc/Peat) formulations.
- **Entomopathogenic nematodes (EPN - *Steinernema*, *Heterorhabditis*):** Mass production *in vivo* (in *Galleria* larvae) or *in vitro* (solid/liquid fermentation) – harvesting, formulation, and storage.

5. Biofertilizers: Types and Sources of Strains

- Definition and importance of biofertilizers in enhancing soil fertility and plant nutrition.
- **Types of Biofertilizers based on function:**
 - **Nitrogen fixers:** Symbiotic (*Rhizobium*, *Bradyrhizobium*), Associative (*Azospirillum*), Free-living (*Azotobacter*, *Glucanoacetobacter*).
 - **Phosphate solubilizers:** *Bacillus*, *Pseudomonas*, *Aspergillus* – convert insoluble phosphates to available form.
 - **Potash releasing microorganisms:** *Frateuria aurantia*, *Bacillus mucilaginosus*.
 - **PGPR (Plant Growth Promoting Rhizobacteria):** Multi-functional (*Azospirillum*, *Pseudomonas*, *Bacillus*).
 - **Azolla and BGA (Blue Green Algae / Cyanobacteria):** For wetland rice.
 - **PPFM (Pink Pigmented Facultative Methylophiles):** *Methylobacterium* – phyllosphere colonizers, promote growth.
 - **AM Fungi (Arbuscular Mycorrhizae):** *Glomus* spp. – enhance P and water uptake.
- Sources of good quality strains: Culture collections (MTCC, IARI, TNAU), and quality assurance laboratories.

6. Production Technology of Biofertilizers

- Facilities and equipment: Fermenters (Shake flasks, bioreactors), Autoclaves, Laminar flow hoods, Incubators, Shakers, Refrigerated centrifuges.
- Raw materials: Media components (Nutrient broth, Yeast extract, Mannitol, Peptone), Carrier materials (Peat, Lignite, Talc, Charcoal, FYM).

- **Production process:**
 - **Carrier-based:** Cultivation of broth → mixing with sterilized carrier → curing → packing.
 - **Liquid-based:** High-density fermentation → addition of cell protectants (glycerol, Trehalose) → packing as liquid concentrate.
- **Specific production protocols:** *Azospirillum*, *Azotobacter*, *Glucanoacetobacter*, Phosphate solubilizers (PSB), Potash releasing microbes, and AM Fungi (mass multiplication on Sorghum roots/other host plants).

7. Storage, Shelf Life, and Quality Standards of Biofertilizers

- **Shelf life:** Carrier-based – 3 to 6 months (at room temperature); Liquid-based – 12 to 18 months.
- **Storage conditions:** Cool, dry, dark place; avoid high temperature and direct sunlight.
- Constraints in mass production: Contamination, low cell count, loss of viability during drying/formulation, poor quality carriers.
- Quality standards (BIS/ICAR-FCO norms): Minimum viable cell count (10^7 to 10^8 CFU/g carrier; 10^8 CFU/ml liquid), pH 6.0-7.5, moisture < 30-40%, no contamination.
- **Quality control biofertilizer lab in Tamil Nadu:** TNAU Biofertilizer Laboratory (Coimbatore) – testing, certification, and quality assurance.

8. Mushroom: Morphology and Common Edible/Poisonous Species

- Mushroom morphology: Cap (Pileus), Gills (Lamellae), Stalk (Stipe), Volva, Annulus, Mycelium.
- **Common edible mushrooms:**
 - **Oyster mushroom (*Pleurotus spp.*):** Fast growing, tropical/subtropical, high yield.
 - **Milky mushroom (*Calocybe indica*):** High temperature tolerant, white large fruiting bodies.
 - **Button mushroom (*Agaricus bisporus*):** Temperate, compost-based.
- **Poisonous mushrooms:** *Amanita* (Death cap – contains amatoxin), *Galerina*, *Lepiota* – symptoms (gastrointestinal, hepatotoxic, neurotoxic).

9. Mushroom Laboratory Techniques and Spawn Production

- **Laboratory techniques:** Sterilization (Autoclaving, Filter sterilization), Media preparation (PDA - Potato Dextrose Agar, OMA - Oat Meal Agar).
- **Pure culture techniques:** Aseptic transfer, streak plate/spread plate, sub-culturing for maintenance.
- **Storage:** Slant cultures at 4°C, periodic sub-culturing, cryopreservation.
- **Spawn:** Mycelium growing on a carrier substrate.
- **Types of spawn:**
 - **Mother spawn:** Pure culture of mushroom mycelium on cereal grains (Sorghum/Wheat) – used for bed spawn production.
 - **Bed spawn:** Mother spawn multiplied on larger quantity of sterile grains – used for direct inoculation of substrate.

10. Mushroom Cultivation: Oyster and Milky Mushroom

- **Substrate:** Paddy straw / Wheat straw (Oyster); Coir pith / Sugarcane bagasse (Milky).
- **Substrate preparation:** Chopping → soaking/pasteurization (Hot water/Steam) → drainage.
- **Spawning:** Layer spawning / Mix spawning – 2-5% spawn on wet weight basis.
- **Cropping:** Spawn run (mycelial colonization) → Primordia formation → Fruiting body development (Harvest at button/umbrella stage).
- **Problems in cultivation:**
 - **Biotic:** Green mould (*Trichoderma*), Cobweb, Bacterial blotch, Fungal gnats, Mites.
 - **Abiotic:** Low/high temperature, poor ventilation, high CO₂, improper moisture.
- **Uses:** Food (protein-rich), Nutraceutical (Beta-glucans – immunity boosting), Pharmaceutical (Lentinans, Antioxidants), and composting of agro-wastes (Coir pith, Straw) into organic manure.

11. Post-Harvest Technology and Value Addition of Mushroom

- **Harvesting:** At proper maturity stage to maximize shelf life and quality.
- **Methods of preservation:**
 - Drying (Sun drying, Hot air oven, Dehydrator).

- Canning (Brine/syrup).
- Freezing (Blanching + Cryogenic freezing).
- Pickling (Vinegar solution).
- **Value addition:** Mushroom powder, Mushroom pickles, Mushroom soup mixes, Mushroom nuggets, and Nutraceutical capsules.

12. Fruit and Vegetable Processing: Equipment and Accessories

- Importance of processing in reducing post-harvest losses and enhancing shelf life/value.
- **Equipments used:**
 - Cleaning/Washing: Soak tank, Spray washer, Brush washer.
 - Size reduction: Pulper, Juicer, Cutter/Slicer, Grater.
 - Heat processing: Pasteurizer, Evaporator, Retort (Canning).
 - Dehydration: Tray dryer, Drum dryer, Spray dryer, Freeze dryer.
 - Filling/Packaging: Bottle filling machine, Vacuum sealer, Pouch packing machine.
- Accessories: Thermometers, Pressure gauges, pH meters, Refractometers (Brix measurement), and Sealers.

13. Preparation of Beverages: Squash, Syrup, Cordial, Nectar, RTS, and Concentrates

- **Definitions and standards:**
 - **Syrup:** 65°Brix, high sugar concentration.
 - **Squash:** 40°Brix – 25-30% fruit juice + 60-65% sugar – consumed after dilution.
 - **Cordial:** Clear beverage – strained/filtered juice + sugar + acidity – no suspended pulp.
 - **Nectar:** 15-20% fruit juice (pulp) + sugar + acid – ready to drink after dilution (1:1).
 - **RTS (Ready to Serve):** 10-15% fruit juice, 10-12°Brix – consumed directly, no dilution.
- **Fruit juice concentrate:** Evaporation of water under vacuum to 60-70°Brix.

- **Fruit paste, powder, bar:** Drum drying/spray drying (powder), fruit bar (rolled sheet dried).

14. Jam, Jelly, Marmalade, Preserve, and Candy

- **Jam:** Fruit pulp + sugar + pectin + acid – cooked to 65-68°Brix – semi-solid spread.
- **Jelly:** Clear fruit juice + sugar + pectin + acid – firm gel (65°Brix) – no pulp.
- **Marmalade:** Citrus fruit jelly with suspended peel shreds.
- **Preserve:** Whole or large pieces of fruit in heavy sugar syrup (70°Brix) – maintaining shape.
- **Candy/Glace/Crystallized fruit:** Fruits impregnated with sugar syrup and dried.

15. Pickles, Tomato Products, and Canning

- **Pickles:** Preservation using Oil, Salt, Vinegar, and spices – lactic acid fermentation or direct addition of acid.
- **Tomato products:**
 - **Ketchup/Sauce:** Strained tomato pulp + sugar + vinegar + spices – cooked to 30-35% TSS.
 - **Puree:** 8-10% TSS – strained tomato pulp.
 - **Paste:** 25-35% TSS – concentrated puree.
- **Canning of Fruits and Vegetables:** Principles – Blanching → Filling into cans → Syrup/Brine addition → Exhausting (air removal) → Seaming → Sterilization (Retorting) → Cooling → Storage.
- **Cut-out analysis:** Quality assessment of canned products – drained weight, Brix, pH, vacuum, and sensory evaluation.

16. Dehydration and Low-Temperature Preservation

- **Dehydrated fruits and vegetables:** Drying to low moisture (<5-10%) – using Hot air, Vacuum, Freeze drying.
- **Re-hydration:** Soaking/boiling of dehydrated product in water to restore texture and taste – re-hydration ratio is a key quality parameter.
- **Preservation by low temperature:**
 - **Refrigeration (Chilling):** 0-4°C – short-term storage.

- **Freezing:** -18°C to -40°C – long-term preservation.
- **IQF (Individually Quick Frozen):** Rapid freezing for high quality.
- **Osmotic dehydration:** Partial removal of water by immersing fruits in hypertonic sugar/salt solution – less energy intensive, followed by conventional drying.

17. Seed Production: Field Selection, Genetic Purity, and Isolation

- Selection of field: Suitable agro-climatic conditions, soil type, previous cropping history, disease-free environment.
- Maintenance of genetic purity: Rogueing (removal of off-types/volunteer plants), avoiding mechanical mixing, proper labeling and record keeping.
- Removal of off-types (plant characteristics – height, maturity, seed shape/colour, disease susceptibility).
- **Isolation distance:** Minimum distance between seed crop and other varieties/same crop (for preventing cross-pollination) – based on pollination type (Self-pollinated: 3-10 m; Cross-pollinated: 200-1000 m).

18. Emasculation, Pollination, and Hybrid Seed Production

- **Manual emasculation:** Removal of anthers before dehiscence in self-pollinated crops – for controlled hybridization.
- **Pollination:** Manual transfer of pollen from male parent to emasculated/fertile female flower.
- **Hybrids:** First generation progeny of cross between two inbred lines (F₁).
 - **Single cross:** A × B (two inbred lines).
 - **Double cross:** (A×B) × (C×D) – used for maize.
- **Use of gametocide (Chemical hybridizing agent - CHA):** Induce male sterility in self-pollinated crops – merits (saves emasculation labour) and demerits (variable efficacy, phytotoxicity, strict timing).
- **Merits and demerits of hybrids vs. varieties:** Hybrids – high yield, uniformity; but high cost, seed non-recoverable; Varieties – low cost, farmer-saved seed, but lower heterosis.

19. Crossing/Emasculation Techniques for Specific Crops

- Step-by-step selfing, emasculation, and crossing techniques for:

- **Rice:** Hot water emasculation / vacuum emasculation – pollination.
- **Millets (Sorghum, Pearl millet):** Hand emasculation (Sorghum) / Use of CMS lines (Pearl millet).
- **Oilseeds (Groundnut, Sunflower):** Hand emasculation (Groundnut – morning) / Use of CMS lines (Sunflower).
- **Pulses (Red gram, Black gram):** Hand emasculation of young buds (after bud opening).
- **Cotton:** Emasculation in evening (squeezing anthers) – pollination next morning.
- **Tomato, Bhendi:** Hand emasculation of unopened flowers (afternoon previous day) – pollination next morning.
- **Clonal multiplication:** Vegetative propagation in *Cumbu Napier* (fodder grass) – maintaining hybrid vigor.

20. Seed Harvesting, Extraction, Processing, and Treatment

- **Harvesting:** Physical indices (Maturity – colour change, drying of leaves/stems, moisture content <20%) and Chemical indices (sugar/acidity ratio, oil content).
- **Extraction techniques:** Threshing (Tractor/Power thresher), Shelling (Rubber roll sheller for paddy, Maize sheller), Fibre extraction (Cotton - saw gin/roller gin).
- **Seed processing:**
 - **Cleaner:** Removal of inert matter, dust, chaff.
 - **Grader:** Size-based grading using screens/sieves (for uniform seed size).
- **Seed treatment:** Physical (Hot water), Chemical (Fungicide/Insecticide coating) and Biological (*Trichoderma*/Rhizobium coating).
- **Seed packaging:** Moisture-proof bags (Polylined gunny bags, HDPE bags) – proper labeling (variety, lot no., germination %, net wt.).
- **Seed storage:** Godowns/Silos – sanitation (disinfection, rodent/bird proofing), moisture control, temperature management, fumigation for pests.
- **Certification procedure:** Field inspection (vegetative/flowering/maturity stages) → Seed sampling → Lab testing (Germination, Purity, Vigour, Moisture) → Certification tag issuance.

21. Nursery Technology: Rootstock Raising and Grafting

- **Land preparation:** Nursery bed preparation (Raised beds / Polybags).
- **Seed treatment:** Soaking in water/GA₃, fungicide treatment.
- **Sowing and raising of rootstocks:** For fruits (Mango, Citrus, Sapota) and flower crops.
- **Application of Liquid Manure:** Diluted cow urine/vermiwash – for seedling growth.
- **Plant protection of rootstock:** Management of damping off, sucking pests.
- **Potting materials:** Red soil, Sand, FYM/Compost (1:1:1 or 2:1:1 ratio).
- **Preparation of pot mixture:** Sieving, mixing, sterilization.
- **Potting of rootstock and hardening:** Gradual exposure to open conditions – irrigation management.

22. Grafting, Budding, and Cutting Propagation

- **Selection of Scion Plants:** Disease-free, true-to-type, vigorous parent plants.
- **Grafting:** Methods – Veneer grafting (Mango), Side grafting (Sapota), Approach grafting (Cashew), Wedge grafting.
- **Aftercare of grafted plants:** Polythene cover / shading, irrigation, removal of rootstock sprouts.
- **Graft separation and hardening:** Gradual removal of covering and shade.
- **Preparation of cuttings:** For ornamental plants (Hibiscus, Rose, Ixora) – semi-hardwood cuttings, 10-15 cm length, basal cut below node.
- **Treatment with growth regulators:** IBA (Indole Butyric Acid) / NAA (Naphthalene Acetic Acid) – for rooting stimulation.
- **Planting in Mist Chamber:** High humidity environment for rooting – beds/polybags.
- **Potting of rooted cuttings and hardening.**
- **Air layering (Gootee):** For fruits (Guava, Litchi) and ornamentals – girdling → root promoting media (sphagnum moss + rooting hormone) → plastic wrapping → separation.
- **Budding:** T-budding / Chip budding – for roses and fruit trees.
- **Maintenance of potted plants:** Regular watering, nutrition (liquid fertilizers), pruning, pest/disease management.

- **Packing and Marketing:** Proper packaging (pots/wraps) and transportation to market.

23. Organic Composting: Nutrient Potential and Composting Methods

- Nutrient potential of different organic manures: FYM (0.5% N, 0.2% P_2O_5 , 0.5% K_2O), Coirpith, Pressmud, Compost, Vermicompost.
- **Preparation of FYM Compost:** Piling of dung + litter → aerobic decomposition with periodic turning.
- **Composting methods:**
 - **Indore method:** Pit composting, layers of organic waste + FYM + earth, regular turning.
 - **Bangalore method:** Anaerobic pit method – layers, no turning.
 - **NADEP method:** Above-ground pit with bamboo/perforated structure – aerobic, faster.
- **Preparation of enriched FYM:** Addition of rock phosphate, K-feldspar powder, biofertilizers to FYM.
- **Coirpith composting:** Coirpith + N source (Urea/FYM) + *Pleurotus* (for lignocellulose degradation) – reduces C:N ratio.
- **Sugarcane trash composting:** Chopping + moisture maintenance + microbial inoculants.
- **Pressmud composting:** Sugarcane filter cake – rich in micronutrients.
- **Farm wastes and weeds composting:** Parthenium composting (after leachate removal to reduce allelopathy).
- **Determination of maturity indices:** C:N ratio (<20:1), darkness/colour, water-soluble carbon, germination index (GI > 80%).

24. Commercial Utility of Organic Manures and Vermicomposting

- Commercial utility: Improvement in soil structure, water holding capacity, microbial activity, slow nutrient release – reduces reliance on chemical fertilizers.
- **Introduction to vermicompost:** Composting using earthworms.
- **Types of vermicompost:**
 - **Bed method:** Compost heap with worms.

- **Pit method:** Compost pit with worms.
- **Brick tank/Concrete tank method:** Commercial.
- **Materials for vermicomposting:** Cattle dung, Agricultural residues, Vegetable wastes, Paper waste, Fruit peels.
- **Preliminary treatment:** Chopping, mixing with cow dung (1:1), partial decomposition (pre-composting) for 15-20 days.

25. Large-Scale Vermicomposting: Requirements and Application

- **Small scale vermicomposting:** For households – bins/containers.
- **Large scale vermicomposting:** Concrete tanks/beds – dimensions (10×2×1 ft), shade.
- **Bedding materials:** Coconut coir, paddy straw, sawdust – provide aeration.
- **Container:** Plastic crates/bricks/wooden boxes – proper drainage.
- **pH:** 6.5-7.5 – adjust with lime/dolomite.
- **Moisture content:** 60-70% – sprinkling water regularly.
- **Temperature:** 20-30°C – avoid direct sunlight.
- **Cover feed substrates:** Cow dung, kitchen waste, leaf litter – added in layers.
- **Selection of right worm species:** *Eisenia fetida* (Red wiggler) – preferred for composting, *Eudrilus eugeniae* (African nightcrawler) – for tropical conditions.
- **Preparation of vermicompost beds:** Filling bedding + worm inoculation (1 kg worms per 1 m² bed) → feeding with pre-decomposed waste → covering with gunny bags.
- **Collection of vermicompost:** Harvest after 50-60 days – separation by hand sorting/mesh/vibration.
- **Vermicompost efficiency:** Higher nutrient content (N 1.5-2.2%, P 1-1.5%, K 1-1.5%), rich in hormones, microbial population.
- **Transportation of live worms:** In moist bedding material with aeration – avoid temperature shock.
- **Application of vermicompost:** Basal dose at 2-5 t/ha – for field crops, vegetables, fruits and ornamentals.

Unit X: Agricultural Extension, Agricultural Economics and Digital Agriculture (30 Questions) (25 sets of Questions)

1. Agricultural Economics: Meaning, Importance, and Scope

- Definition of Agricultural Economics – its role in allocating scarce resources (Land, Labour, Capital, Management) for optimal production and distribution.
- Importance: Contribution to GDP, employment, food security, raw materials for industry, and foreign exchange.
- Scope: Production economics, Farm management, Agricultural marketing, Agricultural finance, and Rural development.
- Sectors of Economy: Primary (Agriculture), Secondary (Industry), Tertiary (Services) – their inter-linkages.

2. Rural Economy: Importance, Problems, and Population Dynamics

- Importance of agriculture in rural economy – employment, livelihood, and ancillary activities.
- Problems of rural economy: Poverty, Illiteracy, Underemployment, Lack of infrastructure, Indebtedness, and Low productivity.
- Population growth and its consequences: Fragmentation of holdings, pressure on land, unemployment, environmental degradation, and food insecurity.
- Agents of production: Land, Labour, Capital, and Organization/Entrepreneurship.

3. Land Distribution, Holdings, and Land Reforms

- Land distribution – operational holdings, marginal, small, semi-medium, medium, and large farmers.
- Man-Land ratio – declining per capita availability of land in India.
- Subdivision and fragmentation – causes and effects on farm efficiency.
- **Land reforms:**
 - **Ceiling on land holding:** Maximum land an individual can hold – surplus land redistribution.
 - **Tenurial reforms:** Security of tenure, regulation of rent, and ownership rights to tenants.
 - **Consolidation of land holdings:** Merging fragmented plots into compact blocks.

- **Co-operative farming:** Joint farming by a group of farmers – success (economies of scale) and failure (lack of cooperation, management issues).
- **Bhoodhan movement:** Vinoba Bhave's land gift movement – voluntary land redistribution – success (moral appeal) and limitations (quality of gifted land, legal hurdles).

4. Rural Labour: Characteristics and Welfare Measures

- Rural labour – definition and classification (Agricultural labour, Non-agricultural rural labour, Casual labour, Attached labour).
- Characteristics: Low wages, seasonal unemployment, illiteracy, indebtedness, migration, lack of social security.
- Agricultural labour – employment patterns, wage rates, and income levels.
- **Minimum Wages Act (1948):** Fixing minimum wages in scheduled employments – enforcement and challenges.
- Other welfare measures: Provident Fund, ESI, MGNREGA (employment guarantee), Pradhan Mantri Shram Yogi Maan-dhan (PMSYM), and State-specific schemes.

5. Rural Banking and Finance: Concepts and Classification

- Meaning and concept of rural finance – provision of credit and savings facilities to rural households.
- Classification of finance based on purpose: Production credit (for inputs), Investment credit (for capital assets), Consumption credit.
- Classification based on time: Short-term (<15 months), Medium-term (15 months to 5 years), Long-term (>5 years).
- Sources of finance:
 - **Institutional:** Government, Cooperatives, Commercial banks (nationalized), Regional Rural Banks (RRBs), Land Development Banks (LDBs), NABARD.
 - **Non-institutional:** Private money lenders, Traders, Landlords, Relatives, Chit funds.

6. NABARD and Multi-Agency Approach in Rural Credit

- **NABARD (National Bank for Agriculture and Rural Development):** Establishment in 1982 – role as an apex development bank.

- Functions: Refinance to banks, supervision/regulation of RRBs and cooperatives, promote rural infrastructure, support self-help groups (SHGs), and implement rural development programs.
- **Multi-agency approach:** Multiple institutions (Commercial banks, RRBs, Cooperatives, NABARD) working together to meet the credit needs of rural areas.
- **Service Area Approach (SAA):** Allocating specific villages/areas to specific bank branches for focused credit delivery and development.

7. Rural Industries: Importance, Classification, and Investment

- Importance of rural industries: Employment generation, income diversification, value addition to local resources, and reducing rural-urban migration.
- **Classification:**
 - Agro-based (Processing of agri-produce).
 - Forest-based (Timber, bamboo, medicinal plants).
 - Mineral-based (Pottery, bricks).
 - Engineering and non-conventional (Repair workshops, solar products).
 - Textile and handicrafts (Handloom, Khadi).
- **Rural Industries Project (RIP) and Khadi and Village Industries (KVI):** Promotion of traditional/rural industries – role of KVIC.
- Investment needs and generation of employment.

8. Agro-Industries and Rural Development Schemes

- Types of agro-industries: Food processing, Oil extraction, Dairy, Poultry, Fisheries, Fruit/Vegetable processing, and By-product utilization.
- Potentials for development from agricultural products and wastes:
 - **Sugarcane:** Bagasse (paper/board), Molasses (alcohol), Pressmud (compost).
 - **Cotton seed:** Oil extraction, Cattle feed.
 - **Banana sheath:** Fibre for handicrafts and paper.
 - **Forestry products:** Timber, Medicinal plants, Tendu leaves, Gum, Lac.
- Rural technologies – Technology gap and economic/social constraints in the spread of technology (lack of awareness, affordability, risk aversion).

- Important recent rural development schemes: MGNREGA, DAY-NRLM (Deendayal Antyodaya Yojana - National Rural Livelihoods Mission), PMGSY (rural roads), PM-KUSUM (solar pumps), and Tamil Nadu's *Chief Minister's Uzhavar Thittam* and *Anaithu Grama Anna Marumalarchi Thittam*.

9. Agricultural Marketing: Concepts, Structure, and Characteristics

- Marketing – definition and scope (Physical movement, Storage, Grading, Processing, Pricing, and Distribution).
- Classification of Markets:
 - Based on location (Village, Primary, Secondary, Terminal).
 - Based on competition (Perfect vs. Imperfect).
 - Based on transaction (Wholesale, Retail).
 - Based on regulation (Regulated vs. Unregulated).
- Structure of agricultural markets: Functionaries (Producer, Trader, Commission agent, Wholesaler, Retailer).
- Characteristics of agricultural commodities: Perishability, Bulkiness, Seasonality, Quality variation, and Price instability – their impact on marketing.

10. Marketing Costs, Margins, and Price Spread

- **Marketing costs:** Costs incurred from producer to consumer (Transport, Handling, Storage, Commission, Packaging, Taxes).
- **Marketing margins:** Difference between the price paid by consumer and price received by producer – profits taken by intermediaries.
- **Price spread:** Difference between farm-gate price and retail price.
- Advantages of a shorter price spread (higher producer share) and problems (many intermediaries, lack of direct market access).
- **Standardization and Grading:** Problems – lack of uniform standards, subjective assessment, inadequate infrastructure.

11. Cooperative Marketing and Regulated Markets

- **Cooperative agricultural marketing societies:** Farmer-owned organizations for collective marketing – reducing exploitation by intermediaries.

- **Regulated markets (APMC Mandis):** Markets regulated by government to ensure fair practices, standardized weights/measures, and transparent price discovery.
- **Role of NAFED (National Agricultural Cooperative Marketing Federation):** Procurement and marketing of agricultural commodities, price support operations, and export promotion.
- **Role of TANFED (Tamil Nadu Cooperative Marketing Federation):** Marketing of agricultural produce and inputs in Tamil Nadu.

12. Specialized Marketing Agencies and Price Support Mechanisms

- **FCI (Food Corporation of India):** Procurement, storage, and distribution of foodgrains (PDS), buffer stock operations.
- **CWC (Central Warehousing Corporation) and SWC (State Warehousing Corporation):** Scientific storage of agricultural commodities, providing warehousing receipts for farmers.
- **CCI (Cotton Corporation of India):** Procurement of cotton at MSP and supply to textile mills.
- **Role of Regulator Markets:** e-NAM (National Agriculture Market) – electronic trading platform for farmers, APMC integration.
- **AGMARK:** Quality certification for agricultural commodities – ensures grade standards.
- **Price support programmes:** Minimum Support Price (MSP) – buffer stock operations for price stabilization.
- **CACP (Commission on Agricultural Costs and Prices):** Recommends MSP for 23 crops – role in price stabilization.

13. Marketing Information, Intelligence, and Input Marketing

- **Marketing information and intelligence:** Collection and dissemination of price trends, demand-supply, arrival data – helps farmers in decision-making.
- **Agmark grading vs. Commercial grading:** Agmark – statutory quality standards; Commercial – brand-specific standards.
- Marketing of agricultural inputs:
 - **Seeds:** Certified seeds, hybrids, distribution through cooperatives/private dealers.

- **Fertilizers:** Subsidized supply, dealer networks, neem-coating.
- **Plant protection chemicals:** Regulated sale, dealer licensing, safe storage.
- **Implements:** Tractor/implement dealership, custom hiring centers.

14. Rural Sociology: Characteristics of Rural Society and Youth

- **Sociology vs. Rural Sociology:** Study of social relationships and institutions in rural areas.
- Characteristics of rural society: Primary groups (family, caste), agricultural occupation, simplicity, joint family system, traditionalism, and community bonds.
- **Rural Youth:** Their needs (education, employment, skill development) and aspirations (migration to cities, modern lifestyle, technology access).
- Basic rural institutions: Panchayati Raj, cooperatives, schools, SHGs, religious institutions.
- Voluntary agencies (NGOs): Role in rural development, technology transfer, and empowerment.

15. Leadership, Motivation, and Social Change

- **Leadership:** Classification (Formal vs. Informal, Traditional vs. Modern, Opinion leaders vs. Decision leaders).
- Characteristics of a good leader: Knowledge, Communication skills, Empathy, Integrity, and Influence.
- Influence of leaders in adoption of agricultural technologies (opinion leaders as change agents).
- **Motivation:** Definition – internal and external forces driving behavior.
- Methods of motivation: Incentives, Recognition, Participation, Training, and Social pressure.
- **Social change:** Meaning – transformation in social structures, values, and behaviors over time – factors (education, technology, urbanization, legislation).

16. Adoption and Diffusion of Innovations

- **Adoption:** Decision to use a new technology/idea on a continuous basis.
- **Stages of adoption:** Awareness → Interest → Evaluation → Trial → Adoption (or Rejection).

- **Adopter categories:** Innovators, Early adopters, Early majority, Late majority, Laggards – their characteristics (age, education, income, risk-taking).
- **Extension methods:**
 - **Individual contact:** Farm visits, Personal letters, Office calls.
 - **Group contact:** Meetings, Demonstrations (Method/Result), Field days, Training camps.
 - **Mass contact:** Radio, Television, Newspapers, Films, Social media.

17. Extension Aids and Communication Technology

- **Audio aids:** Radio, Microphone, Tape recorder, Public address system.
- **Visual aids:** Charts, Posters, Photographs, Models, Slides, Films.
- **Audio-visual aids:** Television, Video, Multimedia projectors, Films.
- **Print and Electronic media:** Newspapers, Pamphlets, Leaflets (Print); Internet, Mobile apps, Email, Podcasts (Electronic).
- **Photography:** Documentation, scientific recording, and visual communication.
- **New achievements in communication technology:** Mobile-based advisory, Kisan Suvidha app, WhatsApp groups for farmer clusters, E-kisan portals, and GIS-based information.
- **Transfer of technologies through:** Demonstrations (Method and Result), Field days, Exhibitions, and Mass media campaigns.

18. Participatory Rural Appraisal (PRA) and SWOT Analysis

- **Visit to a village:** Methodology for rural appraisal.
- **PRA (Participatory Rural Appraisal):** Principles – participatory, interactive, visual, and flexible.
- **Tools of PRA:** Transect walk, Social mapping, Resource mapping, Seasonal calendar, Venn diagram, Timeline, and Matrix ranking.
- **SWOT Analysis:**
 - **Strengths:** Resources, skills, infrastructure.
 - **Weaknesses:** Constraints, gaps, vulnerabilities.
 - **Opportunities:** Potential, schemes, markets.

➤ **Threats:** Climate risks, price fluctuations, resource depletion.

- Preparing an action plan for village development based on SWOT analysis.

19. Visiting Farmers: Resource Analysis and Lifestyle Study

- Analysis of farm resources: Land, Labour, Capital, Livestock, Machinery, Water resources.
- Studying the lifestyle of farmers: Housing, Food habits, Education, Health, Social participation, and Recreation.
- Earnings and enterprise pattern: Cropping pattern, Livestock, Off-farm income, and Non-farm income.
- Expenditure pattern: Consumption, Inputs, Education, Healthcare, Debt repayment, and Savings.
- Technical information seeking behavior: Sources of information (Extension agents, Media, Progressive farmers, Dealers).
- Dissemination of technologies: Factors of adoption (Age, Education, Landholding size, Social participation, Risk perception, Access to credit).

20. Problem Diagnosis Study: Field Problem Solving

- Visiting farmers' fields – identifying technical and frequent problems:
 - Soil problems (Salinity, Acidity, Nutrient deficiency).
 - Pest and disease incidence.
 - Physiological disorders (Blossom end rot, Fruit cracking).
 - Weather-related problems (Drought, Flood, Hail).
 - Weed infestation and management issues.
- Obtaining solutions from known sources: Extension officers, KVK scientists, Agro-dealers, Online portals, Mobile apps.
- Providing solutions to farmers through demonstrations, advisories, and referrals.

21. Visiting Agro-Service Centers: Business and Problem Solving

- Studying the business techniques: Inventory management, Pricing, Credit sales, and Customer relationship.
- Farmers approach: Buying behavior, Credit seeking, Problem reporting.

- Distribution pattern: Dealership structure, Supply chain from manufacturers to retailers.
- Dealership pattern: Exclusive dealers (e.g., TAFE, Mahindra) vs. Multi-brand dealers.
- Knowledge of agro-chemicals available in markets: Pesticides, Herbicides, Fungicides, Plant growth regulators, Adjuvants, and their prices.
- Gaining experience in solving farmers' problems in agro-service centers: Diagnosis of pest/disease based on farmer description/sample, recommending appropriate products.

22. Visiting Vegetable Wholesale Markets (Uzhavar Sandhai)

- **Uzhavar Sandhai (Farmer's market):** Direct farmer-to-consumer vegetable/fruit market – concept and functioning.
- Assessing price fluctuation – daily/seasonal variation.
- Preparing price trend calendar: Tracking price of different vegetables across seasons.
- Preparing line chart for maximum price of different vegetables grown in the district.
- Identifying optimum sowing period for different vegetables based on price trends (market intelligence for planting decisions).

23. Agro-Industries and Food Processing – PMFME Scheme

- Study the potentialities, prospects, and knowledge about starting agro-industries and food processing industries.
- **PMFME (Pradhan Mantri Formalisation of Micro Food Processing Enterprises):** Objectives – formalization, capacity building, and financial support to micro food processing units.
- **Schemes and policies of Government of Tamil Nadu in Agriculture:**
 - *Tamil Nadu Agricultural Development Programme (TNADP).*
 - *Chief Minister's Uzhavar Thittam* (integrated farming).
 - *Kudimaramathu* (tank rejuvenation).
 - *Anaithu Grama Anna Marumalarchi Thittam.*
- **Establishment – Farmers Group – FPO (Farmer Producer Organization):** Concept, formation, registration, and role in collective marketing, input procurement, and processing.

- Role and functions of FPOs: Bargaining power, value addition, market linkages, and credit access.

24. Application of Computers in Agriculture: Multimedia and Online Reporting

- **Computer applications:** Data management, Record keeping, Simulation modeling, and Decision support systems.
- **Multimedia presentation:** PowerPoint – preparing effective presentations for extension/awareness programs.
- **Internet and E-mail:** Communication, information retrieval, and collaboration.
- **Online reporting system:** Digital submission of agricultural data, crop surveys, scheme monitoring, and MIS (Management Information Systems).

25. Digital Agriculture: Apps, Web Portals, AI, and IoT

- **Major Apps and Web Portals for farmers:**
 - **Uzhavan app:** Tamil Nadu Government's app for farmers – crop advisories, subsidy information, market prices, and weather forecasts.
 - **Agris net portal:** Agricultural information system – research updates and extension materials.
 - **Tamil Man Valam app:** Soil health, crop management, and scheme details.
 - **Other latest apps:** Kisan Suvidha, e-NAM app, Meghdoot (weather), Pestmonitor, and Digital India Land Records (DILRMP).
- **Application of Artificial Intelligence (AI) in agriculture:**
 - Crop/soil health monitoring (image recognition for pests/diseases).
 - Yield prediction and price forecasting.
 - Precision farming (variable rate application).
 - Robotics and drone-based spraying.
- **Application of IoT (Internet of Things) in agriculture:**
 - Smart sensors for soil moisture, temperature, humidity.
 - Automated irrigation systems (IoT-based drip/sprinkler).
 - Smart greenhouses and livestock monitoring.
 - Remote sensing integration for real-time farm management.

- Role in improving livelihood of farmers through data-driven decision making and reduced input costs.