Learn… Unlearn… Relearn…

Explore Questions

TNPSC – Agricultural Officer (AO)

Equip for Learning… Prepare for Unlearning… Practice for Relearning…

Paper I AGRICULTURE

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As per the Revised & Updated Syllabus of TNPSC

2nd Revised Edition

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Content

Foreword

Dear Friends,

Greetings from SAAI Academy!

- *DON'T USE THIS BOOK, AT THE LAST MOMENT!*
- *STUDIES AND PRACTICES HELP YOU TO SUCCEED!*

This is the **Book in the series for TNPSC – Agricultural Officer and other competitive exam preparation, second edition**. It contains the Agricultural Studies such as ***Importance of Agriculture, Fundamentals of Crop Production, Natural Resource Management, Crop Management & Allied Agricultural Activities, Crop Improvement, Seed Science and Technology, Crop Protection Principles and Practices, Farm Business and Finance Management, Agricultural Marketing and Marketing Intelligence and Agricultural Extension: Principles and Methods***. Concise the content *w*ith special references to the TNPSC Revised Syllabus for the candidates of Agriculture. It is systematically compiled in a student-friendly manner and updated by keeping in mind the present trends in TNPSC Exam patterns.

You are expected to be self-disciplined and self-motivated, and are **requested to prepare different models of questions as explained during the orientation programme**. **Self-confidence with Systematic and SMART preparation would make you a frontrunner.**

Kindly refer previous year's questions to understand the pattern and type of questions asked, and perform the class test and online tests regularly.

Wishing you ALL THE BEST for your success in the TNPSC exam. For further details, please contact *saaistudies@gmail.com* or call +91-93821 32593.

Best Regards

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Some major investments and developments in agriculture are as follows:

- Investments worth Rs 8,500 crore (US$ 1.19 billion) announced for ethanol production.
- By early 2019, India will start exporting sugar to China.
- The **first mega food park in Rajasthan** was inaugurated in **March 2018.**
- Agri food start-ups worth **US$ 1.66 billion** between **2013-17 in 558 deals**.
- In 2017, the agriculture sector in India witnessed **18 transactions** worth **US$ 251 million**.

Government Initiatives in the sector

- **Pradhan Mantri Kisan Samman Nidhi Yojana (PM-Kisan) - Rs 2,021 crore (US$ 284.48 million)** to the bank accounts of more than **10 million beneficiaries** on February 24, 2019.
- Transport and Marketing Assistance (TMA) scheme to provide financial assistance to boost agriculture exports.
- The Agriculture Export Policy, 2018 - to increase India's agricultural exports to **US$ 60 billion by 2022 and US$ 100 billion in the next few years with a stable trade policy regime.**
- 2018 - 'Pradhan Mantri Annadata Aay SanraksHan Abhiyan' (PM-AASHA)- states can decide the compensation scheme with the private partners to ensure fair prices for farmers in the country.
- 2018, the Cabinet Committee on Economic Affairs (CCEA) - **Rs 5,500 crore (US$ 820.41 million)** assistance to the sugar industry.
- **Rs 2,000 crore (US$ 306.29 million)** for the computerisation of **Primary Agricultural Credit Society (PACS)** to ensure cooperatives benefit through **digital technology.**
- AGRI-UDAAN programme to mentor start-ups and to enable them to connect with potential investors.
- **Pradhan Mantri Krishi Sinchai Yojana (PMKSY)** - Rs 50,000 crore (US$ 7.7 billion) aimed at the development of irrigation sources for providing a permanent solution to drought. ***Har Khet ko Pani "Prime Minister Krishi Sinchayee Yojana".*** **'Har Khet ko pani' - 'More crop per drop'**
- **Triple the capacity of the food processing sector** from the current 10% of agricultural produce and investments for **mega food parks** in the country, under the **Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters (SAMPADA).**
- 100% Foreign Direct Investment (FDI) in marketing of food products **e-commerce** under the automatic route.
- The Electronic National Agriculture Market (eNAM - pan-India electronic trading portal), April 2016 to create a unified national market for agricultural commodities by networking existing Agricultural produce market committee (APMCs). Till May 2018, **9.87 million farmers, 109,725 traders** registered on the e-NAM platform. **585 mandis** in India linked

2. **Digital Agriculture Economy:** transform the entire input supply chain, crop management cycle, storage, and market access through agri innovation start-up ventures. Modernizing agriculture by precision agriculture/ traceability/climate-smart agriculture, creation of digital platforms, and natural resource management. The **AgTech summit in Andhra Pradesh** showcased the latest technology innovation in agriculture.

3. **Enabling Farmer Community:** Through the **Farmer Producer Company** (FPO) formation. Currently, there are over **900 FPOs** (both registered and under process) supported by the **Small Farmer Agribusiness Consortium (SFAC),** which have mobilised approximately **9 lakh farmers.**

4. **Water management**: Agriculture consumes **60% of available water resources**. But, only **47% of agricultural land is irrigated**. Pradhan Mantri Krishi Sichai Yojna (PMKSY) - to bring in more area under irrigated agriculture. The micro irrigation scheme added 6 lakh ha in the current year.

5. **"*Sinchai me Bachat…. Utare mera Karz*"** - partial loan waivers to farmers who use water judiciously, aimed at incentivising water conservation.

6. **The Accelerated Pulse Production Program (A3P)** under the **National Food Security Mission,** an increase in the MSP for pulses. Productivity of the pulses - 764 kg/ha, global productivity - 909 kg/ha.

Sectoral Contribution[2]

Sector	India		Tamil Nadu	
	INR at constant prices	%	INR at constant prices	%
Services	69.36 lakh crore	54.15	9.15 lakh crore	53
Industry	40.29 lakh crore	31.46	5.87 lakh crore	34
Agriculture & allied	18.42 lakh crore	14.39	2.24 lakh crore	13
Gross Value Added (GVA)	128.08 lakh crore	100	17.26 lakh crore	100

The state's per capita income - Rs 1,86,125

Agriculture and the Five-Year Plan in India

1st Five Year Plan (1951-56) – Focus on food grains & commercial crops, mechanization, Fallow land to cultivation. Rs. 354 crores (14.9 %) of the total outlay was spent. Plan vs. Achievement was 7.2 million tonnes vs. 6.5 million tonnes of foodgrains. River valley projects, Irrigational facilities, and fertilizer plants. Bhakara dam, Hirakud dam and Mettur dam. 1955 - Imperial Bank of India became the State Bank of India with the Act of Parliament

2nd Five Year Plan (1956-61) – Food Production, use of chemical fertilizers, raw material support & exportable surpluses. Rs. 501 crores (11.3 percent) of the total outlay was spent.

[2] 2017-18

56. ICAR-Indian Institute of Millets Research, Hyderabad 57.ICAR-Indian Institute of Oilseeds Research, Hyderabad
58. ICAR-Indian Institute of Oil Palm Research, Pedavegi, West Godavari
59. ICAR-Indian Institute of Water Management, Bhubaneshwar
60. ICAR-Indian Institute of Rice Research, Hyderabad
61. ICAR-Central Institute for Women in Agriculture, Bhubaneshwar
62. ICAR-Central Citrus Research Institute, Nagpur
63. ICAR-Indian Institute of Seed Research, Mau
64. ICAR-National Organic Farming Research Institute, Gangtok, Sikkim

National Research Centres -15

1. ICAR-National Research Centre for Banana, Trichi 2. ICAR-National Research Centre for Grapes, Pune
3. ICAR-National Research Centre for Litchi, Muzaffarpur
4. ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur
5. ICAR-National Bureau of Animal Genetic Resources, Karnal
6. ICAR-National Research Centre on Equines, Hisar
7. ICAR-National Research Centre on Meat, Hyderabad
8. ICAR-National Research Centre on Mithun, Medziphema, Nagaland
9. ICAR-National Research Centre on Orchids, Pakyong, Sikkim
10. ICAR-National Research Centre on Pig, Guwahati
11. ICAR-National Research Centre on Plant Biotechnology, New Delhi
12. ICAR-National Research Centre on Seed Spices, Ajmer
13. ICAR-National Research Centre on Yak, West Kemang
14. ICAR-National Centre for Integrated Pest Management, New Delhi
15. National Research Centre on Integrated Farming (ICAR-NRCIF), Motihari

National Bureaux -6

1. National Bureau of Plant Genetics Resources, New Delhi
2. National Bureau of Agriculturally Important Micro-organisms, Mau, Uttar Pradesh
3. National Bureau of Agriculturally Important Insects, Bangalore
4. National Bureau of Soil Survey and Land Use Planning, Nagpur
5. National Bureau of Animal Genetic Resources, Karnal
6. National Bureau of Fish Genetic Resources, Lucknow

Directorates/Project Directorates –13

1. ICAR-Directorate of Groundnut Research, Junagarh
2. ICAR-Directorate of Soybean Research, Indore
3. ICAR-Directorate of Rapeseed & Mustard Research, Bharatpur
4. ICAR-Directorate of Mushroom Research, Solan
5. ICAR-Directorate on Onion and Garlic Research, Pune
6. ICAR-Directorate of Cashew Research, Puttur
7. ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand
8. ICAR-Directorate of Floricultural Research, Pune, Maharashtra

UNIT - II: FUNDAMENTALS OF CROP PRODUCTION

Factors of Production - Agricultural seasons of India and Tamil Nadu - Cropping patterns in India and Tamil Nadu - package of practices of different crops - Agro-Climatic zones of India and Tamil Nadu and their features - Weather and Climate - Weather forecasting - Climate change and its impact – Minimal tillage practices – Stress mitigating technologies including microorganisms – Nanoparticles and their applications.

Factors of Production - Anything that helps in production. Factors of production have been categorized into four types.

Land - primary and natural factor of production. All gifts of nature such as rivers, oceans, land, climate, mountains, mines, forests, etc., are land. The payment for land is rent. **Characteristics are the** gift of nature, no cost of production, immobile & fixed, and limited in supply. **Types of Land** – Residential, Commercial, Recreation, Cultivation, Extraction, Uninhabitable

Labor - All human effort can be mental or physical. The payment for labour is the wage. **Characteristic** - human factor, cannot be stored. **Types of Labor** – Unskilled, Semi-skilled, Skilled & Professional

Capital - all manmade, includes factories, machinery, tools, equipment, raw materials, wealth etc. The capital payment is interest. **Characteristics** – manmade, mobile, passive factor of production. **Types of Capital** – Fixed, Working & Venture

Entrepreneur - a person who brings other factors of production in one place. He is the person who decides - What to produce? Where to produce? & How to produce along with the associated risk. The payment for an entrepreneur is profit. **Characteristics** – imagination, administrative power, man of action, ability to organize, knowledgeable person & professional approach.

Agricultural Seasons of India and Tamil Nadu

Agriculture in India - Indus Valley Civilization Era - before that in Southern India. India ranks **second worldwide** in farm output. **Two main seasons** based on the monsoon.

Kharif - (July –October during the south-west monsoon - Jowar, bajra, rice, maize, cotton, groundnut, jute, hemp, sugarcane, tobacco, etc.) and

Rabi – (October-March (winter) - wheat, barley, gram, linseed, mustard, masoor, pea and potatoes).

Crop	Agro-Climatic Condition
Oilseeds	**Temperature:** 20-30°C **Rainfall:** 50-75 cm **Soil Type:** Well-drained light sandy loams, red, yellow, and black soils
Tea	**Temperature:** 20-30°C **Rainfall:** 150-300 cm **Soil Type:** Well-drained, deep friable loamy soil.
Coffee	**Temperature:** 15-28°C **Rainfall:** 150-250 cm **Soil Type:** Well-drained, deep friable loamy soil.

Four cropping systems in India

1. Rainy Season Cropping Systems: In this system of cropping, Rice, Sorghum, Pearl Millet (Bajra), Maize, Groundnut, and Cotton are grown.

2. Winter Cropping Systems: In this system, wheat, barley and oats, sorghum, and chickpea are grown.

3. Plantation and other commercial crops: Sugarcane, Tobacco, Potato, Jute, Tea, Coffee, Coconut, Rubber, Spices, and condiments are important crops grown in this system.

4. Mixed Cropping: In this system, pulses and some oilseeds are grown with maize, sorghum, and pearl millet.

Types of Cropping Systems in India:

1. Mono-Cropping or Monoculture (only one crop is grown on farm land year after year),

2. Multiple-Cropping (two or more crops on farm land in one calendar year, which includes inter-cropping, mixed-cropping, and sequence cropping) and

3. Inter-cropping (two or more crops simultaneously on the same field in one calendar year)

Cropping pattern of Tamil Nadu

Particulars	Southern Zone	North Eastern Zone	Western zone
Mean annual rainfall (mm)	869.4	1253.8	779.8
Command areas	Periyar Vaigai project	-	Mettur East Bank canal river pumping areas
Soil	Alluvial soils	-	Red and black
Cropping pattern	• Rice (June-Sep.) - rice (Oct.-Jan.) - pulses (Feb.-April) • Rice (June-Sep.) - rice (Oct.-Jan.) - green manure (Feb.-April)		• Rice (Aug-Nov)- groundnut/pulses/gingelly (Dec-March) • Sugarcane (Dec.-Jan.) – ratoon sugarcane (Feb-Jan.) 2 years

Crop	Spacing	Fertilizer FYM,NPK / tree	Special features
Pomegranate (*Punica granatum*) Punicaceae	60cm^3 pit @ 2.5 or 3 m	10:0.2 :0.1: 0.4 kg / 1st yr 30:0.6:0.5:1.2 kg / 6th yr /tree	35^{0}C – 38^{0}C temperature, rooted cuttings / layers of 12-18 months planted @ June-December Kandhari, Musket Red, Kabul, Dholka, Paper Shell, Spanish Ruby, Ganesh, Yercaud -1, Co-1 – Varieties **Training & pruning** removal of 1/3rd of past season shoot, thinning of flower clusters, 1% liquid paraffin @ 15days interval twice (reduce fruit crack) & increase yield. 20-25t/ha/yr.
Jack (*Atrocarpus heterophyllus*) Moraceae India	1m^3 pit @ 8*8 m	10:0.15 :0.08: 0.1 kg / 1st yr 50:0.75:0.4:0.5 kg / 5th yr /tree	22^{0}C – 35^{0}C temperature, 6 – 6.5 soil pH ideal Singapore or Ceylon Jack, Hybrid Jack, Burliar -1, PLR -1, PPI-1 Soft wood grafting on 1.5 months old seedlings with scion of 3-4 months old was successful. Yield from 5th year (grafted plants) & 8th year (seedling trees), march – July harvest period, 30-40t/ha/year
Ber (*Zizyphus mauritiana*) Rhamnaceae	T budding 60cm^3 pit @ 8*3 or 8*4 m	20:0.2 :0.1: 0.2 kg / 1st yr 50:0.5:0.2:0.5 kg / 2nd yr /tree	Kaithali, Umran, Gola, Baharasi – varieties **Training & pruning** remove the rootstock sprout 75 cm above the ground level 70-80kg fruit/tree/yr
Apple (*Malus sylvestris*) Rosaceae			Warm winter resistant with low chilling variety suitable @ Tamil Nadu. 5.8 – 6.2 pH **Early variety** – Iris Peach, Zouches Pipin (April – May Bearing) **Mid Variety** – Carrington & Winter Season (June - July) **Late** – Rome Beauty, Parlin's Beauty, (August - September) 10-20 kg / tree/year after 4th year
Pear (*Pyrus communis*) Rosaceae	60cm^3 pit @ 5*5 or 6*6 m	FYM 2 kg+ 500g of NPK	6 – 7.5 pH, temperate & sub tropical condition **European types** – Bartlett, Anjou, Flemish – Beauty, Max Red Bartlett, Jargonella, **Asian Types** – Keiffer, Gola, Leo Shield / T budding / whip & tongue / cleft grafting – propagation Trained in open centre system & pruned every year @ November to December. 100-120kg/tree yield
Plum (*Prunus*	60cm^3 pit @ 4*4 m	N-24-62 kg: P – 4-13 kg: K 20-23 kg:	President, Victoria, Green Gase, Santa Rosa, Damson, Kelsey, Hale – Varieties

aggregation, while semi-arid regions show better soil structure development.

Physical and Chemical properties

1. Soil *physical* properties

- **Soil horizons** are distinct, parallel layers within a soil profile that reflect different soil-forming processes over time.
- **Horizon formation** results from long-term interactions between climate, organisms, parent material, topography and time (soil-forming factors).
- **Visible characteristics** like color, texture or composition differ between horizons due to varying formation processes.
- **Process indicators** - horizons may show evidence of leaching, illuviation, organic accumulation or other pedogenic processes.
- **Profile representation** - the vertical arrangement of horizons provides a complete cross-section of a soil's development history.
- **Diagnostic value** - horizon patterns help soil scientists classify soils and understand their formation and properties.
- **Variability** - some soils have clearly differentiated horizons while others show more gradual transitions between layers.

Soil Color:

- Oxidized iron (Fe^{3+}) creates brown/yellow/red hues in well-aerated soils, while reduced iron (Fe^{2+}) produces gray/green/blue tones in waterlogged conditions.
- Redoximorphic features (mottled color patterns) reveal soil saturation history, with gray-dominated + mottled soils often being hydric.
- The Munsell system quantifies soil color using hue (e.g., 5YR), value (lightness), and chroma (intensity), written as "hue-value/chroma" (e.g., 5YR 4/3).

Soil Texture:

- Texture depends on the relative proportions of sand, silt, and clay particles in the mineral fraction.
- Sand particles are largest (0.05–2.0 mm), silt intermediate (0.002–0.05 mm), and clay smallest (<0.002 mm).
- Texture influences water retention, aeration, and nutrient availability, determining soil workability and productivity.
- Color reflects aeration status and drainage, while texture governs pore space and root penetration.
- Both properties are critical for soil classification (e.g., identifying hydric soils or determining USDA textural classes like loam or clay).

Sand = <2 to 0.05 mm Silt = 0.05 to 0.002 mm Clay = <0.002 mm

Sand & Silt:

- Considered "inactive" soil components as they cannot retain water/nutrients
- Typically composed of inert minerals like quartz
- Contribute to soil porosity but not chemical reactivity

Clay:

- The "active" soil fraction due to high surface area and negative charge
- Sheet-like structure enables water/nutrient retention via adsorption

Soil consistency - to the ease with which an individual ped can be crushed by the fingers, depends on soil moisture content.

Moist soil:

- loose – non-coherent when dry or moist; does not hold together in a mass
- friable – when moist, crushed easily under gentle pressure between thumb and forefinger, and can be pressed together into a lump
- firm – when moist, crushed under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable

Wet soil:

- plastic – when wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger
- sticky – when wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material

Dry Soil:

- soft – when dry, breaks into powder or individual grains under very slight pressure
- hard – when dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger

Bulk density measures soil compaction as mass per volume (g/cm^3), reflecting how tightly particles are packed.

Pore Space Relationship: Calculated as: Pore space (%) = 1 - (Bulk density/Particle density). Higher bulk density = lower pore space = poorer aeration/root penetration

- Mineral soils: 2.65 g/cm^3 (quartz standard)
- Organic matter: 1.25 g/cm^3 (lighter due to porous structure)
- Organic amendments reduce bulk density by introducing lightweight particles
- Ideal range for plant growth: 1.0-1.6 g/cm^3 (mineral soils)
- 1.8 g/cm^3 indicates severe compaction restricting root growth
    - Soil health/compaction status
    - Water infiltration rates
    - Engineering properties (e.g., load-bearing capacity)
- Tillage temporarily reduces bulk density but may cause long-term compaction
- Sustainable practices (organic matter addition, reduced traffic) maintain optimal density

Soil Chemical Properties

a. Cation Exchange Capacity (CEC) - CEC measures a soil's capacity to retain and exchange positively charged nutrient ions (cations) on negatively charged clay/organic surfaces.

Key Cations: Essential plant nutrients: Ca^{2+}, Mg^{2+}, K^+, NH_4^+. **Acidity indicators:** H^+, Al^{3+}. **Potential contaminants:** Heavy metal cations (e.g., Cd^{2+}, Pb^{2+})

Exchange Mechanism: Dynamic process where adsorbed cations reversibly swap with solution-phase cations. Follows the lyotropic series: $Al^{3+} > Ca^{2+} > Mg^{2+} > K^+ = NH_4^+ > Na^+$

Capacity Determinants: Clay type (2:1 clays > 1:1 clays). Organic matter content (humus has high CEC). pH-dependent charges (variable CEC increases with pH)

- High CEC soils (>25 meq/100g) retain more nutrients but resist rapid changes

of aberrations in weather conditions, especially rainfall.

6. **Mixed and Multiple Agriculture:** to cultivation of crops and raising of animals simultaneously. The multiple farming is used to denote the practice of growing two or more crops together. In such case a number of **crops having varying maturing periods** are sown at the same time. *This practice is followed is areas having good rainfall or facilities of irrigation.*

Inter cropping	Mixed cropping
1. The main object is to utilize the space left between two rows of main crop.	1. To get at least one crop under favorable conditions
2. More emphasis is given to the main crop	2. All crops are cared equally
3. There is no competition between both crops	3. There is competition between all crops growing
4. Inter crops are of short duration & are harvested much earlier than main	4. The crops are almost of the same duration
5. Sowing time may be same or different	5. It is same for all crops
6. Crops are sown in different rows without affecting the population of main crop when sown as sole crop	6. Either sown in rows or mixed without considering the population of either.

7. **Crop Rotation:** This refers to growing of number of Crops one after the other in a fixed rotation to maintain the fertility of the soil. The rotation of crops may be complete in a year in some of the areas while it may involve more than one year's time is others.

- Pulses or any leguminous crop is grown after the cereal crops.
- Legumes have the ability of fixing nitrogen to the soil.
- Highly fertilizer intensive crops like sugarcane or tobacco are rotated with cereal crops.
- The selection of crops for rotation depends upon the local soil conditions and the experience and the understanding of the farmers.

8. **Terrace Cultivation:** The hill and mountain slopes are cut to form terraces and the land is used in the same way as in permanent agriculture. Since the availability of flat land is limited terraces are made to provide small patch of level land. Soil erosion is also checked due to terrace formation on hill slopes.

Types of Farming - Farming can be classified according to what it grows and how it is grown

- Arable: Crops
- Pastoral: Animals
- Mixed: Crops and animals
- Subsistence: Grown just for the farmer and his family
- Commercial: Grown to sell
- Intensive: High inputs of labour or capital, usually small
- Extensive: Low inputs of labour or capital
- Sedentary: Permanently in one place
- Nomadic: The farmers move around to find new areas to farm

Water resource development and management

Water resource management involves planning, developing, and distributing water for optimal use. It is increasingly challenged by climate change, uneven rainfall, and growing

UNIT - IV: CROP MANAGEMENT & ALLIED AGRICULTURAL ACTIVITIES

Cropping systems and integrated farming - Recycling of agricultural waste - Organic manures, green manures, bio fertilizers - Balanced usage - Integrated nutrient management - Physiological disorders in crop plants and their management- Irrigation management of different crops Mushroom cultivation, bee keeping, silkworm rearing etc., Energy in Agricultural production - Sources - Solar, wind, animal, biomass and biogas - Mechanization in agriculture - Tractors & tillers - Agricultural implements and Machineries and their usage - livestock and poultry rearing.

Cropping System and Integrated Farming

Rainfed agriculture occupies 68% of India's cultivated area and supports 40% of the human population and 60% of the livestock population. It produces 445 of the food requirement, thus has and will continue to play a critical role in India's food security.

Cropping system – Refer to Unit II

Sustainable agriculture means an integrated approach to increasing farm yield and managing resources to address all three critical aspects of sustainability: economic, environmental, and social. Integrated Farming Systems (IFS) approach to stabilise income streams through natural resource management and livelihood diversification.

Types of Agroforestry Systems

- Agri-Silvicultural Systems - manage land for the production of crops and forest products
- Silvo-Pastoral Systems - produce both wood products and livestock
- Agri-Silvo-Pastoral Systems - a mixture of the two systems above, which produces tree products, crops, and livestock
- Mixed Garden Systems - integrate trees, crops, and animals on small plots to supply nutrients, materials, and marketable products for a family
- Multi-Use and Production Systems - provide services such as erosion control and watershed recharge while producing forest products and/or crops and livestock.

Types of integrated farming systems

- **Crop-live stock farming system**
- **Crop-live stock -fishery farming system**
- **Crop-live stock -poultry - fishery farming system**
- **Crop-poultry-fishery - mushroom farming system**
- **Crop-fishery-duckery farming system**
- **Crop- livestock-fishery-vermicomposting farming system**
- **Crop-live stock-forestry farming system**
- **Agri-silvi-apiary system**
- **Agri-horti-silvi-pastoral system**

Recycling of agricultural waste

Agricultural waste is composed of organic wastes (animal excreta in the form of slurries and farmyard manures, spent mushroom compost, soiled water and silage effluent) and waste such as plastic, scrap machinery, fencing, pesticides, waste oils, veterinary xmedicines, harvest waste; fertilizer run- off from fields; pesticides that enter into water, air or soils; and salt and silt drained from fields.

4. Slaughterhouse wastes-bone meal, meat meal, blood meal, horn and hoof meal, Fish wastes
5. Byproducts of agro industries cakes, bagasse and press mud, fruit and vegetable processing wastes etc
6. Crop wastes-sugarcane trash, stubbles and other related material
7. Water hyacinth, weeds and tank silt, and
8. Green manure and green leaf manuring material

Manures can also be grouped crops, into **bulky organic manures and concentrated organic manures** based on concentration of the nutrients.

Bulky organic manures - contain small percentage of nutrients and they are applied in large quantities. Farmyard manure (FYM), compost and green-manure are the most important and widely used bulky organic manures. Use of bulky organic manures has several advantages:

- They supply plant nutrients including micronutrients
- They improve soil physical properties like structure, water holding capacity etc.,
- They increase the availability of nutrients
- Carbon dioxide released during decomposition acts as a CO2 fertilizer and
- Plant parasitic nematodes and fungi are controlled to some extent by altering the balance of microorganisms in the soil.

Farmyard manure - to the decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle. On an average well decomposed farmyard manure contains 0.5 per cent N, 0.2 per cent P2O5 and 0.5 per cent K2O.

Sheep and Goat Manure - The droppings of sheep and goats contain higher nutrients than farmyard manure and compost. On an average, the manure contains 3 per cent N, 1 per cent P2O5 and 2 per cent K2O.

Poultry Manure - The excreta of birds ferment very quickly. If left exposed, 50 percent of its nitrogen is lost within 30 days. Poultry manure contains higher nitrogen and phosphorus compared to other bulky organic manures. The average nutrient content is 3.03 per cent N; 2.63 per cent P2O5 and 1.4 per cent K2O.

Concentrated organic manures - have higher nutrient content than bulky organic manure. The important concentrated organic manures are oilcakes, blood meal, fish manure etc. These are also known as organic nitrogen fertilizer. Before their organic nitrogen is used by the crops, it is converted through bacterial action into readily usable ammoniacal nitrogen and nitrate nitrogen. These organic fertilizers are, therefore, relatively slow acting, but they supply available nitrogen for a longer period.

Oil cakes - After oil is extracted from oilseeds, the remaining solid portion is dried as cake which can, be used as manure. The oil cakes are of two types:

- Edible oil cakes which can be safely fed to livestock; e.g.: Groundnut cake, Coconut cake etc., and
- Non edible oil cakes which are not fit for feeding livestock; e.g.: Castor cake, Neem cake, Mahua cake etc.,

Both edible and non-edible oil cakes can be used as manures. However, edible oil cakes are fed to cattle and non-edible oil cakes are used as manures especially for horticultural crops.

Government Solar Schemes for Farmers

1. **Standalone Solar Pumps** – Off-grid solar pumps for irrigation.
2. **Solarisation of Grid-Connected Pumps** – Replacing conventional pumps with solar-powered ones.
3. **Grid-Connected Solar Power Plants** – Farmers can sell surplus solar power to the grid.

- **Target**: **25,750 MW** of combined solar capacity.

India's Solar Power Growth

- **2021-22 Target**: **100 GW** solar capacity.
- **Progress (2017)**: Over **20 GW** installed (18.4 GW ground-mounted, 1.6 GW rooftop).
- **Trend**: Development of **large solar parks** (250+ MW each) in bigger states.

Benefits of Solar in Agriculture

- **Reduces electricity/diesel costs** for farmers.
- **Enhances energy security** with decentralized power generation.
- **Environmentally friendly** – cuts carbon emissions.
- **Additional income** for farmers through surplus power sales.

Future Opportunities

- **Innovative system designs** to integrate solar power with agriculture.
- **Job creation** in rural areas through solar projects.
- **Scaling up solar parks** to meet renewable energy goals.

This shift to solar energy can **transform Indian agriculture** by making it **more sustainable and cost-effective**.

Solar products for agriculture[3]

Innovative Solar-Powered Agricultural Devices in India

1. Three-in-One Solar Integrated Device

  - Solar Water Heater – Produces 50 liters of hot water (50-60°C) in winter.
  - Solar Cooker – Boils food in 2-3 hours without sun tracking.
  - Solar Dryer – Efficiently dehydrates fruits/vegetables with temperature regulation.

- Unique Feature: Uses water as a heat sink, allowing drying to continue at night.

2. PV Winnower-Cum-Dryer

- **Dual Functionality:**
  - Winnowing – Cleans 35-50 kg of grains/hour in the absence of natural wind.
  - Solar Dryer – Reduces drying time by 50% compared to open sun drying.
- **Components:** PV module, winnower fan, pre-air heating tunnel, solar drying cabinet.
- **Benefits:** Retains aroma, color, and quality of dried produce.

3. PV Generator for Orchards (Solar PV Drip Irrigation + Power Generator)

- Primary Use:
  - Solar-powered drip irrigation (900W PV array + 800W DC pump).
  - Covers 4-5 hectares of pomegranate orchards.

[3] Central Arid Zone Research Institute Near Industrial Training Institute (ITI), Jodhpur - 342 003 (Rajasthan) - INDIA

- 1944- Avery, MacLeod, and McCarty discovered DNA is hereditary material.
- 1953- Watson, Crick, and Wilkins proposed a model for DNA structure.
- 1970- Borlaug received the Nobel Prize for the Green Revolution.
- 1994 -"Flavr Savr" tomato was developed as the first genetically modified food produced for the market.
- 1995- Bt corn was developed.
- 1996- Roundup Ready soybean introduced.
- 2004- Roundup Ready wheat developed.

Achievements

- Semi dwarf wheat (Norin-10), Rice (Dee-Gee-Woo-Gen), Hybrids, Nobilisation of cane, Hybrid corn, Hybrid in Sorghum, Pearlmillet, Hybrid cotton.
- Variation occurs in nature by three sources, namely mutation, hybridization (natural), and polyploidy. Using these three sources, genetic variation can be widened in any crop plant

Kinds of Germplasm

A. Land races - primitive cultivars that were selected and cultivated by the farmers for many generations - evolved under subsistence agriculture. Land races have a high level of genetic diversity, which provides them **high degree of resistance to biotic (**diseases and insects**) and abiotic (**drought, salinity, cold, frost**) stresses**.

B. Obsolete Cultivars - Improved varieties of the recent past. These are the varieties that were popular earlier and have now been replaced by new varieties. For example, varieties K68, K65, and Pb 591 were the most popular traditional tall varieties before the introduction of high-yielding dwarf Mexican wheat varieties.

C. Modern Cultivars - The currently cultivated high-yielding varieties. These varieties have high yield potential and uniformity as compared to obsolete varieties and land races. Extensively used as parents in the breeding programme.

D. Advanced Breeding lines - Pre-released plants which have been developed by plant breeders for use in modern scientific plant breeding are known as advanced lines, cultures, and stocks.

E. Wild forms of Cultivated Species - available in crop plants. Such plants have a generally high degree of resistance to biotic and abiotic stresses and are utilized in breeding programmes for genetic improvement of resistance to biotic and abiotic stresses.

F. Wild Relatives - Those naturally occurring plant species that have common ancestry with crops and can cross with crop species - are important sources of resistance to biotic and abiotic stresses.

G. Mutants - Mutation breeding is used when the desired character is not found in the genetic stocks of cultivated species and their wild relatives. Mutations do occur in nature as well as can be induced through the use of physical and chemical mutagens. For example, mutant gene pool Dee-Geo-Woo-Gen in rice and Norin 10 in wheat proved to be valuable genetic resources in the development of high-yielding and semi dwarf varieties in the respective crop species.

Vavilovian Centers of Diversity (Origin) Discussed in Unit 2

The concept of parallel variation, also known as the law of homologous series of variation,

b) Genetic male sterility - Redgram, Castor.
c) Cytoplasmic - genetic male sterility Jowar, Bajra, Rice
3. Use of self in compatibility by planting cross-compatible lines, and hybrids are produced. Here, both are hybrids. – Brassicas, Fruit tree.

Latest varieties of major crops in Tamil Nadu

Varieties released during 2019 have been discussed in Unit 1

[1]Tamil Nadu Agricultural University (TNAU) has released seven agricultural crop varieties and six horticultural varieties for introduction in the State as a Pongal gift to farmers.

The varietal release includes 2 rice varieties — Co53 and ADT54, one variety of sugar cane — CoC 13339, a monopodia cotton (Co17), a blackgram variety VBN11, two millet varieties – Sorghum Co 32 and Tenai ATL 1. While the Co53 could be introduced during late samba season and ADT54 could be released during thaladi season under irrigated conditions, the release said. The mid-late high-yielding CoC13339 will replace the current Co86032 sugarcane. Co17 cotton will help promote mechanized harvest and high-density planting; to overcome the yellow mosaic viral disease in pulses, Blackgram VBN11 is being introduced for adoption, and the two millets have been introduced keeping in mind the nutritional security of children.

The six varieties of horticultural crops recommended for release include banana – Co2, tomato hybrid – Co4, aggregatum onion – Co6, cassava – YTP 2, manila tamarind – PKM - MT2, and manathakkali – Co1.

Breeding for climate-resilient varieties

[2]Realizing the climate-smart potential of food legumes - Food legumes offer many advantages for sustainable agriculture. They add nitrogen to soils through a process known as biological nitrogen fixation; they require minimum inputs, which can reduce the costs of production; and they provide an excellent source of nutrients and proteins. In 2017, ICARDA worked with its national partners to develop 14 climate-resilient varieties of chickpea, lentil, and faba bean, and helped distribute them to farmers in Egypt, Ethiopia, India, Iran, Sudan, Tunisia, and Turkey. The result: stable yields, healthier soils, and enhanced food and nutritional security.

Heat-tolerant wheat thrives in the Senegal River Basin - With the financial support of the Swedish Research Council, ICARDA scientists developed heat-tolerant durum wheat cultivars that can withstand temperatures of up to 40°C in the Senegal River Basin. The ICARDA varieties, identified after three years of multilocation testing, also grow fast, which allows farmers to produce wheat during the fallow period between rice cultivation.

When tested, the varieties yielded over 3 tonnes per hectare in just 90 days, and if scaled up, estimates suggest they could yield up to 600,000 tonnes of new food, and an estimated €180 million in additional revenue for smallholder farmers, without affecting rice production. The initiative – **"Deployment of Molecular Durum Breeding to the Senegal Basin: Capacity**

[1] The Hindu Business line, Published on January 17, 2020
[2] https://www.icarda.org/annual-report-2017/index.html

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